THE

PROCEEDINGS AND TRANSACTIONS

OF THE

Nova Scotian Institute of Science

HALIFAX, NOVA SCOTIA.

VOLUME XIII

PART 2

SESSION OF 1911-1912

HALIFAX
PRINTED FOR THE INSTITUTE BY MCALPINE PUBLISHING CO., LTD.
Date of Publication:—26th August, 1912

PRICE TO NON-MEMBERS: ONE HALF-DOLLAR

CONTENTS

THE attention of members of the Institute is directed to the following recommendations of the British Association Committee on Zoological Bibliography and Publications :—

"That authors' separate copies should not be distributed privately before the paper has been published in the regular manner.

"That it is desirable to express the subject of one's paper in its title, while keeping the title as concise as possible

"That new species should be properly diagnosed and figured when possible.

"That new names should not be proposed in irrelevant footnotes, or annoymous paragraphs.

"That references to previous publications should be made fully and correctly, if possible in accordance with one of the recognized sets of rules of quotation, such as that recently adopted by the French Zoological Society."

PROCEEDINGS

OF THE

Nova Scotian Institute of Science

SESSION OF 1911-12

ANNUAL BUSINESS MEETING.

Electrical Engineering Lecture Room, Technical College, Halifax; 13th November, 1911.

THE PRESIDENT, WATSON L. BISHOP, in the chair.

Other members present: PROF. E. MACKAY, M. BOWMAN, F. W. W. DOANE, P. R. COLPITT, W. MCKERRON, PROF. C. L. MOORE, DR. H. JERMAIN CREIGHTON, PROF. D. S. MACKINTOSH, PROF. C. D. HOWE, H. S. DAVIS, and H. PIERS.

PRESIDENTIAL ADDRESS: (1) Review of the Institute's Work, (2) Death of Dr. R. W. Ells.—By WATSON L. BISHOP.

Gentlemen,—As we are entering upon another year it gives me the opportunity to call your attention to the work of the year which is gone, in order to stimuate further improvement.

We have at last, as an Institute, found an ideal home in the Technical College—the provincial centre of Science *applied.* We have not only comfortable but aesthetic rooms for meeting—large or small to suit the size of the audience. We have at hand facilities for illustrating papers, popular or scientific, to which for nearly half a century the Institute has been a total stranger. We have a large staff of scientific professors at home in the same building and an increased staff of scientific men at Dalhousie University. But all this wealth of facilities failed during the past

Dalhousie. But all this wealth of facilities failed during the past year to produce the output of the old strenuous days when we met in the poorly lighted, badly seated, and primitively warmed and ventilated museum on Cheapside.

It is true, the Institute of 1863 has lost heavily by emigration. The medical doctors formed an association of their own. Those developing mining industries branched out into the Mining Society, of Nova Scotia; and later the engineers swarmed out to form their own hive. But while making allowance for all this, there should surely be better conditions for the development of the scientific cult to-day than ever before. It is therefore with some disappointment I refer to the work of last year. It has not come up to our improved opportunities. Our men of science have been too completely engrossed in the increasingly exacting duties of their various routine public services. We must not forget, however, to keep the vestal fire of scientific research alive in this focus of the community. That is a duty incumbent on everyone engaged in scientific labor, and on every one seeing hope in the scientific cult.

We had three meetings during the past year. The retiring President in the Annual address gave an able sketch of late progress in the production of organic compounds, and made suggestions for our future work which we have not yet attempted to energetically develop.

At our February meeting Mr. Walter H. Prest advocated a preliminary survey of Nova Scotian caves for possible natural history or anthropological remains. Your Council supplied him with some aid for such exploration, an account of the results of which will be presented by Mr. Prest himself at this meeting.

The May meeting brought out some valuable meteorological notes by Mr. F. W. W. Doane, C. E.; a comparison of the monthly mean temperaturs of Halifax and Plymouth on opposite sides of the Atlantic by our ex-President, Dr. Henry S. Poole, F. R. S. C., who does not forget the Institute, although absent from the Province; a sketch of Mineral Occurrences in the Granites at New Ross, Lunenburg County by Mr. A. L. McCallum, B. Sc.; a paper on the effect of gravity on the concentration of solutions, by Mr.

Harold S. Davis, B. A.; and notes on fishes in Nova Scotia by our Secretary Mr. Harry Piers.

This is good work so far as a few members of the Institute are concerned. But more of us should have put new work on its records. Our publication funds and our magnificent exchange list, put us within the reach of privileges and advantages which I trust we may fully exploit during the present year.

Perhaps we should annually attempt at least one or two popular demonstrations of science applied to industries, the conservation of health, or the development of public utilities—something to interest the general public or to inspire the young student.

Death of Dr. R. W. Ells.

We have to record with profound regret the loss during the year of one of our most useful and eminent members. By the passing away of the late Dr. Robert Wheelock Ells, LL. D., F. R. S. C., who died at the late residence on O'Connor street, Ottawa, early Tuesday morning, 23rd May, Canada loses one of her ablest scientists. Dr. Ells had been a member of the Geological Survey of Canada for nearly forty years, having joined the staff under Sir Wm. Logan, the founder of the survey.

The late Dr. Ells was descended from U. E. L. ancestors who came to Nova Scotia in 1761. He was born at Cornwallis, N. S., in 1845 and was educated at Horton Academy, at Acadia University and at McGill University from which he graduated in 1872 with first class honors and the Logan gold medal in geology, and natural history. He married in 1873, Miss Harriett N. Stevens of Onslow, N. S. Joining the staff of the Canadian Geological Survey in 1872, he has since been constantly engaged in geological work in that branch of the service.

He was also a prominent Fellow of the Royal Society of Canada, a Fellow of the American Geological Society, and a member of the Canadian Mining Institute. Besides being a past president of the Ottawa Literary and Scientific Society, Dr. Ells had also been president of the Ottawa Valley Graduates' Society of McGill University, and for a number of years past had held the position of representative Fellow for the province of Ontario

on the Corporation of McGill University. He had published numerous reports on the geology and mineral resources of the provinces of Nova Scotia, Prince Edward Island, New Brunswick and Quebec, as well as of the Northwest Territories and British Columbia. In addition he had written various papers for the Royal Society of Canada, the Geological Society of America, the American Institute of Mining Engineers, the Ottawa Field Naturalists Club, the Canadian Mining Institute and the Nova Scotia Mining Institute.

Dr. Ells was perhaps best known in recent years for his work in connection with the problem of the utilization of the oil shales of Eastern Canada. It was indeed largely through his efforts that attention was first called to the great value of these deposits and his memoir published in 1910 is the standard work on this subject.

From the year 1894 he has contributed many valuable geological papers to our Institute, which will be found in its Transactions.

Our duty is to endeavor to fill up our ranks with new men who will carry on, down the current of time, the good work which makes the past history of our Institute one of the most illustrious in Canada.

The Treasurer, Mr. Bowman, presented his annual report, showing that the receipts for the year 1910-11 were $781.74, the expenditure $540.83, and the balance in current account on 1st November, 1911, was $240.91; while the reserve fund was $696.38, and the permanent endowment fund was $885.58. The report having been audited, was received and adopted.

The Librarian's report was presented by H. Piers, showing that 1,810 books and pamphlets had been received by the Institute through its exchange-list during the year 1910; and 1,357 have been received during the first ten months of the present year (1911), viz. January to October, inclusive. The total number of books and pamphlets received by the Provincial Science Library (with which those of the Institute are incorporated) during the year 1910, was 3,421. The total number in the Science Library on 31st December, 1910, was 42,409. Of these, 32,397 belong to the Institute, and 10,012 to the Science Library proper. That is,

about 76 per cent. are the property of the former, and about 24 per cent. belong to the latter. 626 books were borrowed besides those consulted in the library. No binding or purchasing was done during the year, there being no grant available for the purpose. The report was received and adopted.

The following were elected officers for the ensuing year (1911-12):

President,—WATSON L. BISHOP, *ex officio,* F. R. M. S.

1st Vice-President,—ALEXANDER HOWARD MACKAY, LL. D., F. R. S. C.

2nd Vice-President,—DONALD M. FERGUSON.

Treasurer,—MAYNARD BOWMAN, B. A.

Corresponding Secretary,—PROF. EBENEZER MACKAY, PH. D.

Recording Secretary and Librarian,—HARRY PIERS.

Councillors without office,—PHILIP A. FREEMAN; PROFESSOR FREDERIC H. SEXTON, B. SC.; FRANCIS W. W. DOANE, C. E.; A. L. MCCALLUM, B. SC.; PARKER R. COLPITT; H. JERMAIN MAUDE CREIGHTON, M. A., M. SC., DR. SC., F. C. S.; and PROFESSOR CLARENCE L. MOORE, M. A.

Auditors,—DONALD S. MACINTOSH, M. SC., and ALEXANDER MCKAY, M. A.

The celebration of the fiftieth anniversary of the foundation of the Institute was discussed and referred to the council to take such action as it might think fit.

PROFESSOR MOORE suggested that some method be devised for cooperation work in obtaining data on biological questions in the province. The matter was referred to the council.

FIRST ORDINARY MEETING.

N. S. Technical College, Halifax; 13th November, 1911.

THE PRESIDENT, WATSON L. BISHOP, in the chair.

The ordinary meeting was held on the conclusion of the annual business meeting.

In the absence of the author, MR. PIERS read a "Report on Cave Exploration in Hants County, Nova Scotia," by WALTER HENRY

PREST, of Bedford, N. S., being the result of investigations undertaken by MR. PREST at the request of the council of the Institute. (See Transactions, p. 87). The subject was discussed by PROF. C. L. MOORE, PROF. E. A. HOLBROOKE, PROF. D. S. MACINTOSH, H. PIERS, and others.

SECOND ORDINARY MEETING.

N. S. Technical College, Halifax; 11th December, 1911.

THE FIRST VICE-PRESIDENT, DR. A. H. MACKAY, in the chair.

It was announced that PROFESSOR C. J. CONNOLLY, PH. D., department of biology, University of St. Francis Xavier, Antigonish, N. S., had been duly elected an associate member by the council on 5th November.

MR. PIERS drew attention to the desirability of collecting information regarding the economic and medicinal use of Nova Scotia plants among our Micmic Indians.

In the absence of the author the following paper was read by PROF. C. L. MOORE:—

SACRED PLANTS OF INDIA.—BY CAPTAIN J. H. BARBOUR, R. A. M. C., F. L. S., Nowgong, Central India.

In view of the supreme interest which will centre round India during this present year and culminating in December when His Majesty, the King, will visit the country to hold the great Delhi Durbar, there is certain to be a desire on the part of the many people who will visit the country, some for the first time, to learn before they come, as much about India, her history, customs and manners as they can in order to appreciate the magnificence and significance of this important event in her national life and also to create for themselves an interest in what they may see generally over the country.

There will be much travelling up and down the vast peninsula, and guide books, histories and other literature will be greatly in evidence to elucidate and explain points. There is, however, one subject which may appear insignificant compared with the others and yet it is one which will be very much to the fore wherever the traveller goes, I mean the plants of the country. He will see new

and strange varieties of plants from the time he lands in Bombay till the time he leaves India again, and he will see many which are sacred and associated with Indian religious thought to a very large degree, and hence I have endeavoured to try and write this article in the hopes that it may be a help and pleasure to many who may care to look upon them during their stay in the country, which in many cases will only be for a few weeks or so.

I often wonder how many think about the trees and plants they see when either on their railway journey or when visiting the shrines and temples of ancient India, about which are usually planted trees or plants of a certain kind; and yet the lives of the Hindus are intimtely woven both now and in the past with some of these plants; and the plants themselves, could they but speak, could tell wonderful tales of yore, when the Pantheon of Hindu deities was perhaps more in evidence than it is to-day. Yet to-day it is not by any means obliterated. The old is still with us in India and the native has remained unchanged, except perhaps in the large cities for centuries. Civilization and Western influences have, it is true, prevaded the large centres of the community; but away in the jungle villages, the villager still preserves his reverence for his ancestors' deities and his hopes in the sacredness of his faith and the associations which surround it, and amongst these the trees which form the subject of my article. For these reasons I have thought that it may prove interesting to your readers to tell them something about these plants, what they are like, their uses either economically or medicinally, and their associations, so far as can be found out at the present day. The writer has practically seen all the trees or plants to which he refers and so can speak from experience, both as to their uses and also their interesting points to a great extent. The object of this article being, however, not only to prove interesting, but useful to all who may be thinking of visiting India and wishing to know the native names of the trees, the names of the trees will be given, not only in the Latin form, but in the vernacular and English in each case.

Before proceeding to speak about these plants a word or two must be said on one or two of the chief deities to which these

plants are sacred, and the remainder will be grouped together and referred to as the plants are spoken of.

Let us take Vishnu first as he is the most popular of all Hindu deities in his various incarnations. He is the personification of nature's preserving powers. When the whole earth was covered with water he lay sleeping on a serpent, and while he slept, a lotus sprang from his navel and from it the great Brahma sprang the Hindu god existant. His heaven is on Mount Meru and his incarnations are ten.

Siva, the second and only other great deity I shall here refer to, represents the destructive power of nature, or perhaps I ought to say its transforming and reproducting power, and hence is of both terrible and pleasing dispositions. He is usually represented as a white man with five heads and a third eye in each head, and the heads are surmounted by a crescent moon, and the river Ganges flows, as it were, from his fifth head. His most usual image is, however, the "Linga" which is the sign of reproduction and which is exceedingly common on many temple steps. His heaven is Mount Kackasa.

These are the two chief deities to which most of these trees are sacred, but there are many more; and to these, trees and plants are also sacred. I shall first of all point out the plants sacred to these two deities and then grouping the others, refer to them together. I shall also say a few words about sacred trees which are sacred, as it were, for themselves alone and yet have no doubt a deeper idea beneath.

The following plants are sacred to Vishnu alone: *Ocymum sanctum.*

To Siva: *Aegle marmelos, Crataeva religiosa, Poinciana regia, Zizyphus jujuba, Jasmimum sambac, Gardenia lucida, Michelia Champaca, Ficus religiosa and Ficus Bengaliensis.*

To Siva and Vishnu together: *Jasmimum sambac, Artemisia vulgaris, Nerium odorum, Ixora coccinea, Origanum Marjoram.*

Ocymum sanctum, Vern. "Kalatulsi." Holy Basil. The only plant dedicated to Vishnu, and a most important one it is, though only an herb, erect, softly hairy, with ovate toothed leaves,

small corolla purple in colour. The fruit is reddish brown. Sometimes the plant is purple all over. It is cultivated very much round temples and in Brahmins' gardens, and is highly reverenced.

"Nothing on earth can equal the virtues of a Tulasi" has been quoted often. Puja (that is invocations) is offered to it daily. When a Brahmin is dying, one of the plants is brought and put on a pedestal and puja is offered to it. A bit of the root is put into the mouth of the dying man, and its leaves are sprinkled over face, eyes, ears and chest. He is also sprinkled with a twig of it, dipped in water, from hand to foot. At the same time his friends say aloud "Tulasi, Tulasi, Tulasi"! and the man dies happy and goes straightway and certainly to Swarga. To obtain pardon for all one's sins, it is enough to look at this sacred plant. By touching it a man is purified of all his defects. Salvation is assured to any one who waters and tends it daily. A branch offered to Vishnu in milk will be more pleasing to the god than a thousand cows. A sprig of it dipped in saffron and offered to the god at any time ensures the person's enjoyment of Vishnu's happiness. To give a twig of it to anyone suffering cares and anxieties, ensures a certain means of securing for him a satisfactory ending to all his difficulties. It is much used in native medicine with a supposed excellent results. Its leaves have a sweet aromatic scent and the Brahmins use the plant as an aid to digestion after meals, and after ablutions to prevent getting chills, as it is supposed to have cordial-like effects.

Aegle marmelos, Vern. "Bel." Ball Fruit. A fairly large tree found every where in India and as common in some parts of the jungle as near villages and temples. Its thorns and its flowers are in panicles. The fruit is about the size of an orange, round and smooth with a pulpy interior; and when dried, the appearance is rather honey-combed. The fruit is a well known remedy for dysentery, and it is used a good deal. It is bitter, however. This tree is sacred to Siva.

Crataeva religiosa, Vern. "Warwan." Is found near many temples in Central India and Bengal. A tree with long petioled leaves and ovate leaflets. Flowers in racemes, white or buff with long purple filaments. Fruit large and round or oval. The leaves

are armomatic and are used in rheumatism, while the roots and bark are used in calculi.

Poinciana regia, Vern. "Sandesra." Gold Mohur tree. The most beautiful tree in India in my opinion, and its various names well become it, for it is indeed a queen of trees in its beautiful and graceful green symmetrical fan-like arrangement of branches and leaves which towards the end of the summer take the place of its golden flowers. The flowers are of old gold or striped with red, and the English name is the name of the only gold coin in India. Covered with flowers two or three inches in size across, the tree is indeed in May and June a veritable flame of gold and no description on paper can equal the gorgeous look of one of these trees in full bloom. Siva is highly honored in this tree.

Zizyphus jujuba, Vern. "Bhor." Jujube tree. Not a very large tree, but a thorny one with small ovate leaves, dark green on the upper surface and downy brown underneath. Flowers in cymes, strong smelling and small; fruit the size and colour of a yellow cherry. It is very common everywhere in the jungles, and it is thought to be, as well as being sacred to Siva, the Siora of the Koran, a tree which Mohammed in his miraculous night journey found growing at the further limit of the seventh heaven. The wood of the tree is poor, but the fruit is eaten raw, although it is bitter. Many a time have I seen the natives collecting them in abundance. It has mild medicinal properties as a blood purifier, but otherwise there is nothing striking about it, and one might easily pass the tree without noticing it.

Jasmimum sambac, Vern. "Mogri." Arabian Jasmine. A shrub with oval leaves and racemes of opposite white flowers. Fruit rather small, round, and black. One would always recognize this as a variety of jasmine, and it is appropriately associated with Siva in his reproductive energy, for the leaves are used as a lactifuge; the bruised leaves being applied to the breasts. It stops the secretion of milk in cases of threatened abscesses and hence women must bless Siva for having associated with him such a remedy.

Gardenia lucida, Vern. "Dekamali." English is Dikamali or Gardenia. A large shrub or small tree with smooth shiny oval

smooth leaves. Flowers white and it is often seen as an ornamental shrub in gardens. A strong smelling yellow gum exudes from its shoots and from this an ointment is made which is called by its Hindu name. This ointment I may add is used for foul ulcers and to keep flies off sores. The flower is rather a pretty one and is a valuable addition to the ornamental shrubs of the country.

Michela champaca, Vern. "Champaka." No English equivalent. A fair sized tree, more or less evergreen with long ovate pointed waved leaves. Flowers a delicate pale yellow and very fragrant. Fruit is a spike of carpels. It is a rather curious looking tree and gives, when the leaves are fully expanded, a good deal of shade. The wood is very soft and easily broken. The flowers are used by the native women as ornaments in their hair and are much offered in their temples to Siva. Shelley speaks of the tree thus:—

"The champak odours fall
Like sweet thoughts in a dream."

The pale yellow flowers have a sweet oppressive odour which is celebrated in Hindu poetry, and from the wood images are made of Buddha for temple uses.

Ficus religiosa, Vern. "Pipal." The Peepul tree or sacred fig. A large, smooth handsome tree, spreading somewhat, with leaves long and pointed much. It looks rather like a wide graceful poplar tree. Fruit is size of a black cherry. It is common over India, in the jungle and near temples and places of habitation. It has been known to live for 2000 years. It is found often near where Brahmins perform the ablutions, and the rustle of the leaves in a breeze has been compared to the sounds of a cithara. Under this tree Vishnu is supposed to have been born by some. No one is allowed to cut it down or lop off branches. Leaf-pulling is only allowed for acts of worship. Each tree springing from an unpreceived source is emblematical of the body which really springs from, and is one with the godhead. It is also said to typify the universe. Sometimes this tree is invested like a Brahmin with that great honor the "triple cord" which only Brahmins among the castes of India can aspire to. Sometimes it is solemnly married, as other trees and plants are to each other in India. In

the case of the Peepul tree, a Margosa tree (*Melia Azadirachia*) is usually chosen as its mate, or occasionally a plantain (*Musa*) Here and there one may on roadsides see a Peepul tree and a Margosa tree side by side in little mounds. This union is not accidental, but a true marriage union. They are wedded by actual ceremonies used for Brahmins and after a time it has been seen the branches of the two trees actually intertwine and their trunks are incorporated with each other.

Ficus Bengaliensis, Vern. "Wad." Banyan tree. A fine tree possession aeria roots, smooth bark, light greenish leaves, ovate and downy beneath, smooth and shining when old. Fruit, deep-red in colour, size of a cherry. Common in the plains and jungles and may grow to an immense size as the famous one in the Nerbudda Valley, Central Provinces of which Arnold speaks:—

"Its ample shade
Cloistered with columned drooping and roofed
With vaults of glistering green."

With this tree also marriages are celebrated. A Palmyra palm may be seen apparently growing out of the trunk of a Banyan, but it is really the other way on, the palm being the older, the seeds of the Banyan being dropped in its fronds and throwing its roots to the ground. (Roxburgh).

We now come to the trees sacred to Vishnu and Siva together. I have already described the Jasmine and I pass on to the others.

Artemesia vulgaris, Vern. "Daona." Wormwood. A tall strong herbaceous plant, leaves pinnated or lobbed deeply, toothed and cut. Flowers in panicles, very small and florets yellowish. Bract, leafy or dry. An uninteresting plaint in my opinion from a purely botanical point of view. It is curious, however, to note that in Old Testament history it is associated with distress and calamity and possibly this association may also be seen in its association with the Hindu Siva, in his terrible embodiment. It is worthy of note that absinthe is made from some species of Arthemesia.

Nedium odorum, Vern. "Kanher." Oleander. A plant or shrub rather known in European conservatories and considered to

be very poisonous, even out here. It has beautiful red flowers and long linear lanceolate leaves.

Hooker thinks, "the willow of the brook" in Scripture to be the Oleander; and he states that wood, flowers and leaves are all very poisonous, but I have heard of its being used out in India, and I have read of fatal results. The resim is considered by natives to be useful in easing colic and stomachic pains and warming if taken internally; and externally, it is reputed to be antiseptic, but I have not yet been able to find out why! It is, however, mostly used internally in hysteria. It makes a very bright show when in full flower, its rosy red bloom being both delicate and graceful.

Ixora coccinea, Vern. "Bakora." Torch tree. A shrub with smooth obovate leaves, flowers bright scarlet in close umbels or corymbs, calyx minute, corolla lobes, broad pointed. It is rather like a geranium and is called also the "jungle geranium," and it is probably the Bandhuka of Sanskrit poetry.

Origanum Marjoram, Vern. "Marva." Majoram. A plant with no particular beauty, it contains a volatile oil which is used for different purposes and being aromatic in character is or has been used in temples because it gave fore a sweet smelling savor for the deities; and its medicinal properties also make it acceptable as a plant for the deities and for the native as well. Now besides the plants that are sacred to the deities already given, there are a number more which are sacred to other deities or groups of deities and the first of these is Kama or Kama Devi, the Hindu cupid or god of love. He is the son of Lakshmi and is represented similarly to the way cupid is at the present day, but he may ride on a red parrot or lory.

The plants sacred to him are: *Mesua Ferrea, Pandamus fascicularis, Mangifera Indica,* and *Michelia champaca* (already described).

Mesu Ferrea, Vern. "Nag Champa." Mesua. A beautiful tree sometimes growing sixty or seventy feet high with oblong lanceolate leaves, shining above and whitish beneath. Flowers, solitary or in pairs, large silvery white with bright yellow anthers. Fruit, oval and pointed. A tree which has been considered by

some as the most beautiful on earth and with blossoms of a delicately fragant odour, and fit indeed for Kame-Devis quiver. In Ceylon it is near every Buddhist temple and the flowers have been said to resemble white roses, while the shorts and buds of the tree are of deep crimson. The flowers also have been described as camellia-like in character and its foliage a mass of glossy green. Its timber is splendid, and Wordsworth's quotation matches it well:

"A silver shield with boss of gold
That spreads itself some fairy bold
In fight to cover."

It yields an aromatic oleo-resim and the dead flowers are used as a fragrant adjunct for decoctions and oils.

Pandamus fascicularis, Vern. "Kevri." Screw-pine. A cactus-like shrub (there are no true indigmous cactuses in India) with long sword-shaped sharply toothed spinous leaves. The flowers look like innumerable filaments and grow on a spadix 3 or 4 inches long, inclosed in leaf-like bracts. Fruit nearly round, something like a pineapple. The tender white leaves of the flowers have a delightful fragrance. Roots are sent out from many parts of the stem and give the idea of the tree being propped up by them. It is the Kevada or Sanskrit poetry, and a perfumed oil is extracted from the flowers which is called 'Kevde.'

Mangifera Indica, Vern. "Amb." Mango tree. Smooth, leaves oblong and lanceolate. Flowers, small in greenish yellow panicles, fruit large and greenish and yellow, and varying somewhat in shape from oval to irregularly round. A fine tree which grows all over India and has been planted everywhere. The fruit is easily the finest Indian fruit and possesses a subtle and delicate flavour, its only disadvantage being its immense stone. It has the reputation that it must be eaten in one's bath on account of its difficulty to handle, but I have not found it necessary to go to such length to enjoy it. The tree when in full bloom and many together, is rather pretty, though individually the flowers are modest. The smell of the flowers by night when out driving along the jungle roads is rather strong and some think them oppressive. The best ones are the Bombay Mangoes, famous all the world over. Every village temple or shrine is well planted with

them, for they afford good shade as well as a most nourishing fruit. The unripe fruits are made into sherbets, pickles, chutnies. The stone or kernel contains tannic acid and turpentine and the pulp of the ripe fruit gallic acid, and gum in traces. The Am Chur which is very popular amongst Indian native troops is a valuable anti-scorbutic. This form of the fruit is that of the green mangoes dried, skinned and stoned, cut into pieces. Half an ounce of this is said to be equal to an ounce of good lime juice. Mango food is a favorite diet with Europeans, just as gooseberry food is at home, and in my opinion it has a very strong resemblance in flavour.

I now come to the plants sacred to the Hosts of Heaven, by which we mean the nine regents of the planets and eclipses, and these give their names to the days of the week, and I give them as they may prove interesting to readers of the article generally.

Rair, the sun regent, Sunday. Soma, the regent of the moon, Monday. Mangala, Tuesday. Buda, regent of Mercury, the author of a hymn in the Rig-veda, Wednesday. Brihapati, Thursday. Sukra, Friday. Sani, Saturday. Rahu and Ketu, eclipses.

To these Hosts of Heaven are sacred the:

Hibiscus Rosa-Sinensis, Butea frondosa, Acacia Catechu, Ficus religiosa (already described), *Ficus glomeratus, Poa cynosuroides.*

Hibiscus Rosa-Sinensis, Vern. "Jasud." Shoe flower. The different varieties of Hibiscus are numerous in India and form beautiful shrubs and useful vegetables, and all are more or less formed on one type, that of a variety of mallow, to which natural order they belong. The above is probably better known as the China rose and is common in gardens in India and I believe is to be found in different parts of America and elsewhere, and so will be more or less generally known to your readers It is a rather pretty plant and the flowers are used in various disorders But I wonder if anyone of your readers know that an oil is made by mixing the juice of the fresh petals with olive oil in equal parts and boiling till the water is evaporated is useful as a stimulating application to the hair. Possibly some ladies may care to know of a new hair wash or a hair producer. Anyhow the natives out

here believe it to be useful and it seems to me to be a very simple preparation.

Butea frondosa, Vern. "Pallas.' The bastard teak. The vernacular name of this tree is taken from the famous field of Plassy on which our fortunes in India so much depended. It is a common jungle tree in early spring and when in flower is covered with beautiful scarlet-orange flowers which make a wondrous colour effect. Hence its fancy names "flame of the forest," and "pride of the jungle," which nearly all Anglo-Indians know it by. Seen closely the individual flowers are much the same colour, but the calyces which are of a very deep greenish-brown, and exactly like velvet, throws the scarlet into showy relief, and as the flowers are in panicles the effect is more striking still.

The bark of the tree contains a gum, which is full of tannic and gallic acids. The gum and flower juice is used for making dyes. The bark is used for snake-bites.

It is indeed a flower which

"With a scarlet gleam
Cover a hundred leagues, and seem
To set the hills on fire."

Acacia Suma, Vern. "Khair." Catechu. A small tree with white bark, thorny, leaves compound, leflets 30 to 50 pairs, flowers white, pod strap-like. A well known rather delicate tree, but not a particularly interesting one to look upon. Catechu, its English name, is an extract from this tree, and is so well known that no coments are necessary on it. Its chief use in India is that it is one of the ingredients of the packet of Betel leaves chewed by the natives, which I suppose is one of the common things one notices travelling through the country any where. Be it remembered, however, that this packet, however objectionable it may be to us and however discolouring to the mouth and lips, contains several useful ingredients which probably make life more agreeable to the native and certainly in some cases staves off sickness, colic, etc.

Kath-Bol is a mixture of catechu and myrrh given to women after confinement as a tonic and to induce a flow of milk.

Ficus glomerata, Vern. "Gular." The Gular fig. A large tree with leaves oblong or broadly lanceolate, fruit in clusters on the trunk or branches, small, red downy. The wood is a fair timber, and the fruit is edible. A bath made of the fruit and bark with water is regarded as a cure for leprosy. The liquid extract from the root is used as a tonic from the Vaidvans. It is a fairly common tree over the country and may often be recognized quickly by the growth of galls on its leaves.

Poa cynosuroides, Vern. "Kust." Dharba grass. This is not a grass as its name suggests, but belongs to the natural order, Boraginaceae, and grows on damp marshy swamps.

Brahmins always keep it in their houses and it is used in all ceremonies, including sacrifices.

It grows to a height of two feet and has a finely pointed top and is rough to the touch.

There are several legends regarding the origin of this sacred plant. One, that it was produced at a time when gods and giants were all busy churning with the mountains of Mandara, the Sea of Milk in order to extract from it Amrita or nectar which would render them all immortal. The story goes on to say that while the mountain was rolling about on Vishnu's back, who in the form of a turtle was supporting it, it rubbed off a great many hairs from the god, and that these hairs cast ashore by the waves, took root there and became Dharba grass. One wonders where the hairs on a turtle's back are, but this is a legend. Another legend is that while the gods were greedily drinking the nectar which they had extracted from the Sea of Milk, let fall some drops on the ground among ordinary grass which thus became sacred and grew up as Dharba grass .

Dharba grass although sacred to the hosts of Heaven is also considered to be part of Vishnu himself, and Brahmins worship it, and in their ceremonies use it, believing that it has the virtue of purifying everything. An annual feast is instituted in honor of it on 8th day of the Moon in the month of Badra (September), and is called Dharba-ashtami. By offering the grass as a sacrifice on that day immortality and blessedness for ten ancestors may be assurred. Another result is that one's posterity is increased and

multiplied like Dharba grass which is one of the most prolific plants in the vegetable kingdom.

We have still another set of sacred trees which are sacred to the nine forms of Kali. The Kali represented in India in ancient days the same as the old Roman patricians and refer to the ghosts or shades of ancestors. It will be noticed that some of those plants which are referable to deities are also to these spirits, such as *Aegle marmelos, Ocymum,* etc. But there are certain of special ones also, *Musa sapientium, Curcuma longa, Saraca Indica, Punica granatum.*

Musa sapientium, Vern. "Khela." The cultivated plantain. Its appearance is now probably well known all the world over now-a-days, and need hardly be described. Its specific name conveys an allusion to one of Theopharastus' statements concerning a fruit which served as food for the wise men of India, supposed to have been the plaintain.

It is worshipped by the Hindu woman on the 4th of Kartik Shudh in order that their husbands may survive them. Bunches the fruit are used in festivals and ceremonies, and are placed at the entrances to their houses on such occasions, especially at marriages, as appropriate emblems of plenty and fertility.

Some people consider it to have been the forbidden fruit of Eden and again that it was the grape of the Promised Land.

Curcuma longa, Vern. "Haldi." Twemerie. Herbaceous. The leaves are long, broad and lanceolate, the leafy stem is four to five feet high. The flowering bracts pale green and the coma a beautiful pink. The plant is known in Bombay by its Hebrew name "Karkam," and it was evidently known in England as early 1710 or earlier. The uses of twemerie are well known, and I only intend to say that the oil is used by the natives in small-pox and chicken-pox. The rubbing of the oil is an essential part of Hindu wedding ceremonies and the root enters into many religious ones. By the root, I mean tuber underground. Mixed with lime, it forms the liquid used in the Arati ceremony of warding off the "evil eye." With lime juice, the Hindus of the sect of Vishnu prepare their yellow Tiruchurnum, with which they make the

peculiar mark on their forehead. Visitors to India must often have seen the numerous marks of different sects and castes.

Punica granatum, Vern. "Anar." The Pomegranate. It is sufficiently well known with its scarlet orange flowers and avidulated fruit to need no description. It grows well in other parts of Asia and Greece as well as India, where it was and is held sacred and symbolic of fructification and procreation and also death and resurrection.

Giotto placed a pomegranite in the hands of Dante, and Raphael crowned Theology with blossoms of its flowers.

In the old testament it is referred to, and it is seen in Assyrian and Egyption sculpture. In India it has often been referred to by Sanskrit writers, and has been seen in its sculpture. Several alkaloids are obtained from various parts of the plant and also organic acids and mannite.

Saraca Indica, Vern. "Ashoka." The Asoka tree. A small tree belonging to the Leguminoseae, but unlike the usual type, it hardly looks like a flower of this order. The flowers are orange, changing to red in large round heads with long stamens. The pod is broad, flat or scimitar shaped. It is a beautiful sight to see when in full bloom, and its soft Hindu name occurs frequently in old Indian poems. The flowers are used in temple decorations and as a symbol of love is also dedicated to Kama. It possesses a certain charm in preserving chastity and it is also a tree of refuge, as in the legend of Buddha, when Maya is conscious of having conceived the Buddis-Attya, she retires to a wood of Asoka and sends to her husband.

The tree is also held sacred by the Burmans as under it Gaudama was supposed to have been born.

It is much used by native physicians in womb affections, the bark being mixed with milk and made into the form of a decoction. Asoka Grita is made from the bark and clarified butter to which some aromatic herbs are added.

There are a few other plants which are held sacred, but which I must omit from this article if I am to endeavour to keep it within reasonable limits. The ones I have told something about are important and fairly common ones, and the writer

trusts they may prove interesting, both to those who have had a tour through India and to those who intend coming, and serve as a sort of brief popular botanical and folk-lore appendix to guide-books which may not touch upon this part of sight-seeing in detail.

The foregoing paper was discussed by H Piers, F. W. W. Doane, Dr. A. H. MacKay, Prof. Moore, and D. M. Ferguson; and a vote of thanks was passed to Dr. Barbour for his interesting paper, on motion of Messrs. Piers and McCallum.

Third Ordinary Meeting.

N. S. Technical College, Halifax; 8th January, 1912.

The President, Watson L. Bishop, in the chair.

It was announced that Captain J. H. Barbour, Royal Army Medical Corps, F. L. S., of Jabalpur, C. P., India, had been duly elected a corresponding member by the council on 28th December.

Harry Piers, curator of the Provincial Museum, Halifax, read a paper entitled "Brief Account of the Micmic Indians of Nova Scotia, and their Remains," the subject being illustrated by a typical set of specimens of their ancient and modern implements, customs, etc. (See Transactions, p. 99). The paper was discussed by the President, Dr. A. H. MacKay, Dr. E. Mackay, Dr. A. Stanley Mackenzie, D. M. Ferguson and William McKerron.

Fourth Ordinary Meeting.

The First Vice-President, Dr. A. H. MacKay, in the chair.

H. Jermain Maude Creighton, M. A., M. Sc. Dr. Sc., F. C. S., lecturer on physical chemistry, Dalhousie University, Halifax, read a paper on "The Optical Activation of Racemic Bromcamphor Carboxylic Acid by means of Catalysts: the Specificity of Catalysts." (See Transactions, p. 1). The subject was discussed by Prof. E. Mackay, Dr. A. H. MacKay, D. M. Ferguson, and Professors Bronson, MacIntosh and Harris.

Fifth Ordinary Meeting.

N. S. Technical College, Halifax; 11th March, 1912.

The President, Watson L. Bishop, in the chair.

It was announced that David Fraser Harris, M. D. C. M., D. Sc., B. Sc. (Lond.), F. R. S. E., Professor of physiology and histology, Dalhousie University, had been elected an ordinary member by the council on 29th February.

Harold S. Davis, B. A., Instructor in physics, Dalhousie University, Halifax, read a paper on "The Conductivity of an Aromatic Base in Water and certain Organic Solvents." (See Transactions, p. 40). The subject was discussed by Dr. H. J. M. Creighton and Prof. E. Mackay.

H. Jermain Maude Creighton, M. A., M. Sc., Dr. Sc., F. C. S., lecturer on physical chemistry, Dalhousie University, Halifax, read a paper on "The Behavior of Iron Salts, in the presence of Egg Albumen and other Organic Substances, towards certain Reagents." (See Transactions, p. 61). The subject was discussed by C. B. Nickerson, Prof. E. Mackay, Dr. A. H. MacKay, and D. M. Ferguson.

Sixth Ordinary Meeting.

N. S. Technical College, Halifax; 9th April, 1912.

The Second Vice-President, D. M. Ferguson, in the chair.

In the absence of the author, Mr. Piers read a paper by Lawrence W. Watson, M. A., Charlottetown, P. E. I., on "The Geological Age of Prince Edward Island." (See Transactions, p. 145). The paper was discussed by R. H. Brown, H. Piers, and others; and a vote of thanks was passed to Mr. Watson.

C. B. Nickerson, M. A., Demonstrator in chemistry, Dalhousie University, Halifax, read a paper on "The Qualitative Separation of Metals of the Iron Group; a New Method for the Removal of PO_4''' Ions." (See Transactions, p. 95). The subject was discussed by Dr. H. J. M. Creighton.

David Fraser Harris, M. D., D. Sc., B. Sc. (Lond.), F. R. S. E., Professor of physiology and histology, Dalhousie University, Halifax, read a paper entitled, "On the Intimate Associations of

Inorganic Ions with Native and Derived Proteins." (See Transactions, p. 76). The paper was discussed by Dr. Creighton, L. C. Harlow, and D. M. Ferguson.

Seventh Ordinary Meeting.

The President, Watson L. Bishop, in the chair.

Mr. Piers reported that the council had under consideration the celebration of the fiftieth anniversary of the foundation of the Institute in December, 1862, the celebration to take place in December of this year, and that a committee had been appointed to deal with the matter and to report to the council, and that this committee would be glad to consider any suggestions from the members in general.

The Second Vice-President, D. M. Ferguson, took the chair, while the President, Watson L. Bishop, read a paper on "The Canada Grouse (*Dendragapus canadensis*) in Captivity: its food, habits, etc." (See Transactions, p. 150). The subject was discussed by H. Piers.

J. H. L. Johnstone, B. Sc., Demonstrator in physics, Dalhousie University, Halifax, read a paper on "The Electrical Resistance and Temperature Coefficient of Ice." (See Transactions, p. 126). The paper was discussed by Dr. Creighton, and a vote of thanks was presented to Mr. Johnstone.

A paper by A. H. MacKay, Ll. D., F. R. S. C., superintendent of education, on "Phenological Observations in Nova Scotia, 1911," was read by title. (See Transactions, p. 175).

Harry Piers, curator of the Provincial Museum, read a paper on "Mastodon Remains in Nova Scotia." (See Transactions, p. 163). The subject was discussed by D. M. Ferguson.

A paper by H. Jermain Maude Creighton, M. A., M. Sc., Dr. Sc., F. C. S., lecturer on physical chemistry, Dalhousie University, Halifax, "On the Electrical Conductivity of Acetophenone Solutions of certain Alkaloids and other Organic Bases," was read by title. (See Transactions, p. 154).

Harry Piers,
Recording Secretary.

TRANSACTIONS

OF THE

Nova Scotian Institute of Science.

SESSION OF 1911-1912

On the Behaviour of Iron Salts, in the Presence of Albumens and Other Organic Substances, Towards Certain Reagents.—By Henry Jermain Maude Creighton, M. A., M. Sc., Dr. Sc., *Lecturer on Physical Chemistry,* Dalhousie University, Halifax, N. S.*

I. Introduction.

In the course of another investigation, it was observed by the writer that, under certain conditions, solutions of soluble Prussian blue were decolorized by white of egg. As the writer was unable to obtain any satisfactory information regarding this behaviour, the present investigation was carried out with a view of throwing new light on the associations of iron with native and derived proteins.

The prevention of many reactions by the presence of certain organic substances is well known. For example, the precipitation of ferric and aluminium hydroxides is prevented by the presence of small quantities of non-volatile organic acids, notably tartaric acid[1], of sugar, of glycerine, and of other organic substances. The cause of this is to be found in the formation

* Contributions from the Science Laboratories of Dalhousie University — [Chemistry].

1. Staedeler and Krause : Jahresb., 746, (1854).

of a soluble complex ion brought about by the entrance of the metal into the hydroxyl group of these substances.

It has long been known that albumen manifests a marked tendency to hinder many chemical reactions. The cause of this may be either physical or chemical. *von Meyer* and *Lottermoser*[1] have shown, for instance, that small quantities of egg albumen prevent the precipitation of silver hydrosol by salts. The effect of albumen on the ionization of silver nitrate has been investigated by *Galeotti*[2] who found, that small quantities greatly diminish the concentration of the silver ions. It is possible that albumen may, in some cases, diminish the ionization of a substance to such an extent as to prevent its recognition by the usual tests. Albumen readily forms complexes with salts of both the alkali and the heavy metals, as well as with many bases and all the mineral acids except ortho- and pyro-phosphoric acid. These albumen compounds may be divided into two classes: those in the which the metal is present as a simple cation; and those in which it forms part of a complex anion, and in which, for this reason, its presence cannot be demonstrated by ordinary reagents. Complexes formed by albumen with HCl, HNO_3, H_2SO_4, $NaOH$, KOH, $NaCl$, KCl, $MgCl_2$, $CaCl_2$, $(NH_4)_2SO_4$, $MgSO_4$, Na_2SO_4, and K_2SO_4 have recently been studied by *Mayer*[3]. The existence of the complex can often be readily shown. For example, when hydrochloric acid is added to a solution of white of egg and the mixture filtered so as to remove the precipitate which forms, it is found that no silved chloride is thrown down on the addition of silver nitrate to the filtrate. With salts of most of the heavy metals albumen forms compounds of the type[4]

$$MO.\ C_{12}H_{112}N_{18}SO_{22};$$

but with iron salts the compound is more complex[5]. These

1. von Meyer, E., and A. Lottermoser: J pr. Chem., **56**, (2) 214, (1897).
2. Galeotti, G.: Zeitschr. physiol. Chem. **42**, 330, (1904).
3. Mayer, A.: Compt. rend., **143**, 515, (1906).
4. Piotrowski: Jahsesber. über die Fortschritt der Chemie, 534, (1857).
5. Brücker: Zeitschr. für Chemie, 61 (1871).

compounds are unstable and the albumen may be recovered by treatment with acids, when it is precipitated and the metal goes into solution.

Physiologists have long divided iron compounds into two classes; those which contain "organic" iron, and those which contain "inorganic" iron. *Macallum*[1] has shown that haematoyxlin may be used to distinguish between these two classes of compounds; and in the experiments which follow I have employed this reagent to demonstrate the condition of the iron.

The terms "bound" and "unbound", as used by Prof. Fraser Harris are, I think, to be preferred to the more ambiguous "organic" and "inorganic". As even better than "bound" and "unbound", however, I would suggest the use of the terms *"non-ionic"* and *"ionic"*; for inorganic or unbound denotes the simple ionic state, while organic or bound denotes a condition which is not elementary, but often quite complex. A compound containing "ionic" iron would be one in which the iron exists as a cation; and in a compound containing "non-ionic" iron the iron would not be present as a simple ion, but would exist as *part* of a complex ion, usually as part of the anion. This classification is justified by experiment, for compounds such as ferric chloride, ferrous sulphate, ferric acetate, and potassium ferri-ferrocyanide (soluble Prussian blue), all of which contain a simple iron cation, give a deep blue black or violet black colouration with haematoxylin; while, on the other hand, compounds such as potassium ferricyanide or potassium ferrocyanide, in which the iron is not present as a simple ion, but as part of a complex anion, give no reaction with haematoxylin.

II. Experimental.

Albumen: A 15% white of egg solution, a 10% solution of Merck's "Egg Albumen granular", and a 10% solution of Merck's "Serum Albumen" were used in the following experiments. The egg and serum albumen were dissolved in very

1. Macallum, A. B.: J. Physiol, 22, 92, (1897-1898).

dilute sodium chloride solution. These solutions were filtered before using.

Haematoxylin: A 0.5% solution of haematoxylin was used in the following experiments.

(a) *Experiments with ferric chloride.*

To 10 c. c. of 1.0% ferric chloride solution 10 c. c. of the white of egg solution were added and the mixture divided into two parts. One portion was allowed to stand at room temperature for a few minutes, and the other kept at 60° for the same length of time. The two portions were divided into several parts and treated with different reagents. The following results were obtained:

With NaOH no precipitate formed.
" NH_4OH no precipitate formed.
" $K_3Fe(CN)_6$ no change.
" $K_3Fe(CN)_6$ slight blue precipitate formed.
" KCNS deep red colouration.
" $(NH_4)_2S$ black precipitate formed.
" Haematoxylin violet black colouration appeared.

Similar results were obtained when 10 c. c. of either the serum albumen or the egg albumen solutions were employed instead of the white of egg solution. It was found with these substances that some of the reagents caused albumen to separate from the solution. Control experiments, in which the albumen solution was replaced by an equal volume of distilled water, were carried out. In these it was found that sodium hydroxide, ammonium hydroxide, potassium ferricyanide, and potassium ferrocyanide all threw down the usual precipitates.

On addition of the albumen solutions to the ferric chloride, it was observed that the brownish colour of the mixtures gradually deepened on standing, thus suggesting that albumen increased the degree of hydroysis of the iron salt. This result was also observed when a mixture of white of egg and ferric

chloride was warmed. To 5 c. c. of 1.0% ferric chloride solution 5 c. c. of the white of egg were added in one case, and in another the chloride was diluted with 5 c. c. of distilled water. These solutions were kept at 65° for ten minutes. At the end of this time the solution containing the albumen was found to be of a deeper colour than the other. To determine whether the non-formation of a precipitate of ferric hydroxide or of Turnbull's blue, in the foregoing experiments, was due to the conversion of the iron into colloidal ferric hydroxide by hydrolysis, sodium acetate was added drop by drop to a solution of ferric chloride, until its colour was somewhat deeper than that of the mixture of white of egg and ferric chloride that had been warmed; on adding ammonia to the acetate solution a heavy precipitate of ferric hydroxide was thrown down, thus proving that only a small quantity of the iron in the egg solution was in the form of colloidal hydroxide.

Hydrochloric acid was found to produce a precipitate when added to a solution of ferric chloride and albumen. To a mixture of 5 c. c. of 1% ferric chloride and 10 c. c. of the white of egg solution a few drops of dilute hydrochloric acid were added. At the end of some minutes no precipitate was observed to have formed. With several c. c. of the acid, however, a precipitate was slowly thrown down. The precipitate was filtered off, and to different portions of the light yellow filtrate ammonia, haematoxylin, potassium ferrocyanide, and potassium sulphocyanide were added. In each case the usual reaction for ferric iron took place. Further addition of hydrochloric acid precipitated no more alubumen from the filtrate. On boiling some of the filtrate, albumen coagulated and was thrown out of solution. This was filtered off and potassium ferrocyanide added to the almost colourless filtrate. The dark blue precipitate was removed by filtration. On boiling the colourless filtrate a light blue flocculent precipitate separated from the solution. The results obtained in this experiment point to the existence of a complex of the iron salt with the albumen. This complex is

stable towards heat. When potassium ferrocyanide is present, however, the complex is precipitated by boiling the solution.

A mixture consisting of equal parts of the white of egg and 1.0% ferric chloride solution, was found to be more stable towards heat than a pure albumen solution of the same concentration; whereas the mixture did not commence to coagulate until the temperature was raised to 65°, the pure albumen solution became cloudy at 61.5°.

(b) *Experiments with potassium ferricyanide.*

White of egg solution, egg albumen, and serum albumen were all found to prevent the precipitation of potassium ferricyanide, in dilute solution, by ferrous salts. On the addition of a few drops of ammonium ferrous sulphate to a mixture consisting of 2 c. c. of 0.1% potassium ferricyanide and 5 c. c. of the white of egg solution only a very faint blue colouration was produced. When the concentration of the potassium ferricyanide was smaller than this, a blue colouration did not occur on the addition of the ammonium ferrous sulphate. 5.0 c. c. of 0.1% potassium ferricyanide were mixed with 25 c. c. of the white of egg solution. Ammonium ferrous sulphate solution was then added drop by drop to the pale yellow mixture until it became colourless. This disappearance of the yellow colour points to the occurrence of chemical change on the addition of the ammonium ferrous sulphate, and is probably due to the disappearance of the ion to which the colour of the solution is due. A blue black colouration appeared when a few drops of haematoxylin were added to part of the decolourised solution. The decolourised solution turned blue on the addition of a drop of dilute hydrochloric acid. Excess of hydrochloric acid caused a blue precipitate to separate slowly from the solution.

With solutions containing no albumen and the above concentrations of potassium ferricyanide, ammonium ferrous sulphate gave deep blue precipitates.

To a mixture of 5 c. c. of 0.1% potassium ferricyanide and 25 c. c of the white of egg solution, sufficient dilute hydro-

chloric acid was added to throw down a white precipitate. The precipitate was filtered off and small portions of the filtrate were tested with ammonium ferrous sulphate, and haematoxylin. The former gave a deep blue precipitate, but no reaction occurred with the latter reagent. To the remainder of the filtrate more hydrochloric acid was added, but no further precipitation took place; on boiling, however, a white precipitate separated from the solution. It was found that the light yellow filtrate from this precipitate could be boiled without further precipitation taking place. To the cooled filtrate a few drops of ammonium ferrous sulphate were then added. The solution turned blue, and on standing a deep blue precipitate separated out; on boiling the solution the precipitate became flocculent, resembling a precipitate of aluminium hydroxide. The precipitate when heated on a platinum foil charred at a low temperature. This precipitate could not have consisted of simply Turnbull's blue; for when ammonium ferrous sulphate was added to a hydrochloric acid solution of potassium ferricyanide having the same degree of yellow colour as the above filtrate, and the mixture boiled, the precipitate which separated out was not flocculent, but finely divided. Moreover, on allowing it to settle and pouring off the supernatant liquid the blue precipitate was found to dissolve in water. The results of this experiment suggest the formation of a complex by the iron salt and albumen, which is stable towards heat, and which is precipitated by ammonium ferrous sulphate.

Like ferric chloride, potassium ferricyanide increases the coagulation temperature of albumen. A solution of potassium ferricyanide and white of egg, of one half the concentration previously employed, first became turbid at 64.5°; while a pure white of egg solution, of the same concentration, became cloudy at 61.5°. When, besides the potassium ferricyanide and white of egg, a very small quantity of ammonium ferrous sulphate was present in the solution, coagulation did not take place below 75°.

(c) *Experiments with potassium ferric-ferrocyanide (soluble Prussian blue).*

It has already been mentioned in the introduction that, under certain conditions, white of egg solution is capable of decolourizing a solution of soluble Prussian blue. Neither the egg albumen nor the serum albumen were found to decolourize soluble Prussian blue as readily as the white of egg solution.

10 c. c. of 0.05% soluble Prussian blue were mixed with 10 c. c. of the white of egg solution and the mixture kept at 60° for an hour. At the end of this time the deep blue solution had become practically colourless. The fading of the blue colour took place gradually. With pure white of egg, or at a higher temperature, the decolourization of the soluble Prussian blue was found to proceed with greater rapidity. When a mixture of equal volumes of 0.05% soluble Prussian blue and the white of egg solution were kept at room temperature, no apparent change in the intensity of the blue colour of the solution was observed at the end of six hours. To some of the decolourized solution haematoxylin was added; *no precipitation occurred,* thus proving that the Fe^{III} ion of soluble Prussian blue was no longer present as such. The addition of dilute hydrochloric acid or concentrated salt solutions to some of the decolourized solution caused the precipitation of a white substance, which gradually turned to a deep green blue colour on standing or on treatment with hydrogen peroxide. No change was observed on the addition of hydrogen peroxide to some of the decolourized soluble Prussian blue mixture.

Like the foregoing mixtures of iron salts with albumen, a solution of 0.05% soluble Prussian blue and an equal volume of the white of egg, which had been decolourized by heating at 60°-70°, was stable to heat and could be boiled without the albumen coagulating. Indeed, it was found that the substances could be rapidly brought to boiling immediately after mixing without precipitation taking place. At this temperature the mixture became colourless in two or three minutes.

(d) *Experiments with gelatine.*

On account of the close relationship between the albumens and the albuminoids, the following experiments were carried out to determine the influence of the presence of the latter substances on reactions of certain iron salts. As a typical albuminoid gelatine was employed. A 10% solution was found to be quite fluid at 20°.

No precipitation of ferric hydroxide occurred on the addition of ammonia to a mixture consisting of equal volumes of 1.0% ferric chloride, 6% gelatine solution, and distilled water; haematoxylin, however, gave a violet black colouration. In a control experiment ferric hydroxide was precipitated by ammonia.

1 c. c. of 0.1% potassium ferricyanide and 5 c. c. of 6% gelatine solution were added to 5 c. c. of distilled water. Although the mixture turned blue on the addition of ammonium ferrous sulphate, no precipitate formed. The blue colour disappeared from this solution on boiling. With 8 c. c. of 10% gelatine solution no blue colouration appeared on the addition of ammonium ferrous sulphate to the mixture; if however, besides the ammonium ferrous sulphate, a few drops of hydrochloric acid were added, the solution turned blue and a precipitate of Turnbull's blue slowly formed. In the control experiments, in which the gelatine solution was replaced by an equal volume of distilled water, a deep blue precipitate was obtained on the addition of the ammonium ferrous sulphate.

It was found that a mixture containing 5 c. c. of 0.05% soluble Prussian blue and 5 c. c. 6% gelatine could be kept at 95°-100° for one and a half hours without the blue colour of the solution appreciably decreasing in intensity. With 7 c. c. of 10% gelatine, however, the colour of the Prussian blue faded completely under these conditions. The blue colour of the mixture returned on the addition of a few drops of either dilute hydrochloric acid or hydrogen peroxide. With hydrochloric

acid the blue colour was deeper than with hydrogen peroxide. When a decolourized solution was allowed to stand for twenty-four hours, the jelly, which formed on cooling, was found to be deep blue at the surface. The blue colour gradually decreased until, at a depth of three inches, the jelly was colourless.

(e) *Experiments with ferrous salts.*

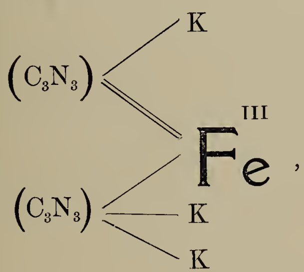
Dilute solutions of ammonium ferrous sulphate and potassium ferrocyanide were separately mixed with varying quantities of the white of egg solution, and allowed to stand some minutes. On adding ammonia or sodium hydroxide to the ferrous ammonium sulphate mixtures ferrous hydroxide was invariably precipitated. When the concentration of the white of egg was relatively large, the ferrous hydroxide precipitated somewhat slowly. The potassium ferrocyanide mixtures were tested with solutions of iron alum and copper sulphate. On the addition of a few drops of the alum solution to the mixture a deep blue precipitate was always produced, while with the copper sulphate solution a brick red precipitate of copper ferrocyanide was immediately formed. The same results were obtained when gelatine was used instead of white of egg.

(f) *Experiments with other organic substances.*

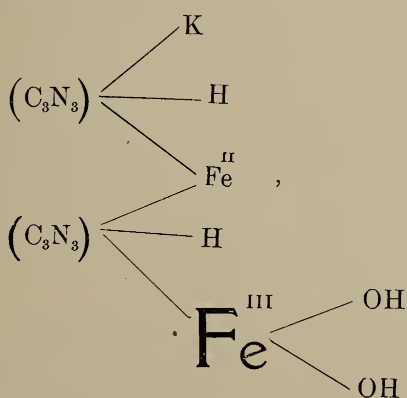
Dilute solutions of all the iron salt previously used were separately mixed with varying quantities of cane sugar, of tartaric acid, and of glycerine. The mixtures containing soluble Prussian blue were kept at 60° for an hour, while the others were allowed to stand at room temperature for some minutes. Apart from the prevention of the precipitation of ferric hydroxide on the addition of ammonia or sodium hydroxide to the mixtures containing ferric chloride, it was found that neither sugar, tartaric acid, nor glycerine apparently hindered the different iron salts from reacting with the various reagents previously used for their denomstration.

III. Discussion of Results.

From the experiments described, it will be seen that albumens, as well as the closely related albuminoid gelatine, tend to prevent certain reactions of ferric chloride, potassium ferricyanide, and soluble Prussian blue; while on the other hand, the presence of albumen or gelatine does not appear to hinder reactions with ferrous ammonium sulphate or potassium ferrocyanide. The prevention of reactions of iron salts by albumen or derived proteins, such as gelatine, seems to be closely associated with the state of oxidation of the iron; for ferric chloride, potassium ferricyanide



and soluble Prussian blue



each contain at atom of trivalent iron. In potassium ferricyanide the trivalent iron forms part of the anion Fe $(CN)_6^{III}$.

As to just how reactions of compounds containing trivalent iron are hindered or prevented by the presence of native or derived proteins, three possibilities present themselves: either the protein may decrease the dissociation of the iron compound to such an extent that ionic reactions are no longer possible; or it may exert a so called "protective action" on the iron salt, similar to that of gelatine on colloidal gold, which is due to the gelatine forming a very thin coating over each of the gold particles[1]; or, lastly, the protein may be *intimately associated* with the iron salt. Intimate association of the protein and the iron salt may be brought about through the formation of a *chemical compound,* or by *adsorption,* giving rise to what may be looked upon as a *physical* compound.

If the phenomenon were to be ascribed to either decrease in dissociation or to protective action, we should expect proteins to hinder reactions of salts containing bivalent iron as well as those of salts containing trivalent iron. On the other hand the *specificity* of the proteins employed, points to their *intimate association* with trivalent iron.

It is well known that many colloids have a tendency to adsorb certain substances, which are in true solution, with the formation of so called adsorption compounds. Since such compounds do not possess a constant composition they cannot be looked upon as chemical. The formation of such compounds depends on several factors of which the following are the more important: the nature and structure of the colloid, the nature of the solvent, the nature of the dissolved substance, the condition of the molecule of the dissolved substance, and lastly, the temperature.

In the foregoing experiments the nature and structure of the colloidal albumen and gelatine are not very dissimilar, while those of the ferric and ferrous salts employed are greatly so. In view of what has been said we should expect to find

1. Mines, G. R.: Proc. Physiol. Soc., November 18th, 1911.

ferrous, as well as ferric salts, adsorbed by albumen and gelatine. That this is not the case at once suggests that the selective adsorption of trivalent iron may be due to some electrical effect. In support of this it may be mentioned it has recently[1] been pointed out, that while the adsorption of non-electrolytes is probably due to surface tension phenomena, that of electrolytes is probably of electrical origin.

Additional evidence of the adsorption of ferric compounds by native and derived proteins is afforded by the fact that the coagulation temperature of albumen is increased by these substances. This behaviour is in accordance with that observed by *Pauli* and *Handovsky*[2], who found that small concentrations of alkali salts retarded the coagulation of albumen, i. e. raised the coagulation temperature.

The supposition of the formation of a chemical compound is supported by the raising of the coagulation temperature of albumen when trivalent iron is present; by the disappearance of the colour of soluble Prussian blue on the addition of albumen or gelatine to its solution; and by the fact that the rate of fading of the blue colour increases as the temperature of the solution is raised. This last is a further argument against the hindering of the reactions being brought about by the protein lessening the degree of dissociation of the iron compounds. The fact that hydrochloric acid when added to mixtures of potassium ferricyanide and albumen or gelatine, such as used in the foregoing experiments, liberates the ferricyanide so that it is demonstrable by ammonium ferrous sulphate and, in the case of albumen mixtures, also precipitates the albumen; the return of the blue colour to solutions of soluble Prussian blue that have been decolorized with gelatine, on the addition of hydrochloric acid, hydrogen peroxide, or on exposure to

1. Lachs, H. and L. Michaelis : Zeitschr. Elektrochem., **17**, 1, (1911) ; ibid. **17**, 917, (1911).

2. Pauli, W. and H. Handovsky : Beitrage z. chem. Physiol. u. Pathol., **11**, 415, (1908).

the air for some time; the white or pale blue precipitates thrown down by hydrochloric acid from solutions of soluble Prussian blue decolorized by albumen; and the fact that this latter precipitate turns to a deeper blue on treatment with hydrogen peroxide or on exposure to the air, constitute additional evidence of the existence of a chemical complex. The return of the blue colour to colourless solutions of soluble Prussian blue and gelatine, and to the substance precipitated by hydrochloric acid from colourless solutions of soluble Prussian blue and abumen, indicates that in the soluble Prussian blue protein complex the trivalent iron of the soluble Prussian blue has undergone reduction and is present in the bivalent condition.

The results obtained in this investigation indicate that native and derived proteins prevent the ordinary reactions of substances containing trivalent iron, owing to the formation of associations between the protein and the iron salt. There is reason to believe that this phenomenon is partly physical and partly chemical: physical in that the colloid attracts the iron salts and forms adsorption compounds; and chemical in that the proteid actually combines with the iron salt. These physical and chemical complexes are readily broken down by hydrochloric acid. Complexes of soluble Prussian blue with gelatine are also decomposed in solution by hydrogen peroxide, but those with albumen are not. One the other hand, these complexes seem fairly stable towards heat, and in the case of those formed with soluble Prussian blue a temperature of 100° does not effect decomposition. Through the formation of complexes of proteins with soluble Prussian blue, the trivalent iron of the latter is probably reduced to the bivalent condition. No indication that complexes are formed by proteins and salts containing bivalent iron has been obtained. Neither cane sugar, glycerine, nor tartaric acid appear to form chemical or adsorption compounds with either ferro- or ferri-salts.

It is the intention of the writer to extend these experiments.

In conclusion it may be pointed out that the results of this paper are not without physiological significance, for the ready formation of chemical or physical complexes between native and derived proteins and compounds containing trivalent iron, either as cation or as part of the anion, may possibly throw new light on the metabolism of iron[1].

Department of Chemistry, Dalhousie University,
Halifax, Nova Scotia,
March 2nd, 1912.

---

1. See the following paper in this Journal, by Professor Fraser Harris.

On the Intimate Associations of Inorganic Ions with Native and Derived Proteins.—By David Fraser Harris, M. D., D. Sc., F. R. S. E., *Professor of Physiology and Histology,* Dalhousie University, Halifax.*

Read 8th April, 1912.

We must assume that unless united to the living molecules (biogens) no food would be assimilated, no drug benefit us, and no poison harm us. We must have some sort of union, incorporation or molecular linking, and that cannot be outside the sphere of atomic affinities. Protoplasm must be chemically viewed as an unstable, molecular, protein complex to which, probably as side-chains, adhere carbohydrate molecules and fat molecules and many inorganic ions both anions and cations. The unmasking of this fat is called in pathology "fatty degeneration," the unloosening of this sugar is called tissue-diabetes. We have fat necrosis after certain poisonings; for instance, phosphorus and alcohol can unmask fat in many tissues of a persons the very opposite of obese, while after chloroform or an excessive percentage of carbon dioxide in the blood we have glycohaemia and the consequent glycosuria which means that the poison has displaced the sugar and sent it into the blood-stream. But further, a salt-free (ash-free) protoplasm, that is, salt-free living protein is only a conception of the chemists; protein is ash-free only in the laboratory. No doubt these ionic side-chains constitute mere traces, but as inorganic substances they play an exceedingly important part in the activities and existence of living matter. A salt-free diet will not support life. Dogs fed on ash-free fats, carbohydrates and proteins were moribund in twenty-six to thirty-six days.

---

* Contributions from the Science Laboratories of Dalhousie University—[Physiology].

But, further, the salts of the diet must be present in it in their natural unions and not merely in a solution added to the organic food. Whereas mice throve on a diet of dried cow's milk, they were moribund in twenty to thirty days on the sugar, fat and casein of milk to which a solution of the extracted salts of milk had been added. We know that a diminution in the amount of potassium absorbed will lead to scurvy.

It used to be said that as the salts contribute no energy, they are not incorporated into the living matter; this is quite a mistake, for although they do not yield energy, they are incorporated as truly as is the fat or carbohydrate or oxygen. It would appear that all the following must be present in the tissues and fluids, not necessarly all in all: sodium, potassium, calcium, magnesium, iron, phosphorus, chlorine, iodine, fluorine and arsenic. Without these, the living matter is not functionally intact: there is a metabolism of the inorganic as truly as there is of the organic.

Take the case of the beating heart; if perfused with distilled water, even containing oxygen and dextrose, it will shortly stop beating, and a loss of salts from it can be proved to have occurred. Now give it a perfusion-fluid with sodium chloride whose osmotic pressure is equal to that of the sodium chloride in the heart, and still it stops. This is found to be because we have left out the potassium and the calcium; the addition of these, the potassium chloride as dilute as 1 in 10,000 is enough, will cause the heart to beat rhythmically. Apparently the cardiac myoplasm establishes an equilibrium between certain organic ions within itself and others in the lymph of its spaces, the point of equilibrium being dependent upon the osmotic pressure of these substances in the surrounding fluids and on the affinities of the protoplasm for these substances. If any one ion predominates somewhat over the others, that is, is present in higher concentration than exists in normal lymph, effects which have been called "toxic" will supervene; thus if potassium is too abundant we have the heart stopping in potassium diastole,

if calcium be too abundant we have the heart stopping in the systole of calcium rigor.

Now the affinities of certain kinds of protoplasm for certain ions are quite different from those of other kinds of protoplasm for them. Thus the red corpuscles fix potassium and iron, the brain, phosphorus; the muscles, potassium; the bones and teeth, calcium and fluorine; the thyroid gland, iodine; and the fluids of the body chiefly sodium. The thyroid gland can, moreover, fix more iodine per unit of tissue than can any other tissue. Chemically speaking, therefore, protoplasm in different situations is chemically different; the protoplasm of the brain has not the same atomic affinities as that of muscle or bone or thyroid gland. The tissues are, however, supplied by lymph of practically uniform composition, so that these chemical differences have been said to be due to "selective affinity." Now these differences must be very slight. Dr. Jermain Creighton[1] has shown that egg-albumin, a native protein and a very direct product of living matter, can distinguish in its selective affinity between iron in the trivalent and iron in the divalent state. Dr. Creighton has found that egg-albumin apparently forms a union with the ferri-ion whether that be as in ferric chloride or in soluble Prussian Blue, (pottassium ferri-ferro-cyanide), both of which have trivalent iron as a cation; or in potassium ferricyanide in which trivalent iron is part of a complex anion. Some late work has shown the iron in haemoglobin to be the ferri-ion: so that it would appear that the point is not whether iron is cation or anion but whether it is tri- or di-valent. The difference is physico-chemically very slight, and yet the albumin takes cognizance of it. In accordance with these views some pharmacologists assert that simple anaemia is cured only by ferric salts. Dr. Creighton has further shown that even gelatine exhibits analogous selective affinities. Here, I think, we are in presence of some very important facts as indicating

1. Creighton, H. J. M.: Trans. N. S. Inst. Science xiii, (2), 61—75, (1911-1912).

the delicate nature of these unions of colloids with metallic ions, unions, which in some cases have been labelled "adsorptions." Now if this sort of thing can go on in non-living albumin what may not be chemically possible in the living bioplasm itself? Dr. Creighton speaks guardedly of "a complex" between the protein and the iron; but we may at least hold a salt-like union is effected and that the tri-valent iron is chemically bound. In accordance with this we have to remember Professor Macallum's test[1] for inorganic versus bound iron: a dilute (0.5%) solution of pure haemotoxylin gives with inorganic iron a blue black coloration, but with bound iron no reaction. Under the latter heading come haemogobin and both the potassium ferricyanide and the potassium ferrocyanide. In these the iron atom is bound in some fashion so as not to affect the haemotoxylin in the manner in which it can do when in the unbound condition of inorganic salts presumably ionised.

It used to be said that inorganic salts given as drugs have a tendency to be deposited in the liver; in more modern terminology it would be said that the hepatic protein has the power of binding the inorganic ions—mercury, arsenic, manganese, etc.—and therefore retaining them in the liver and so preventing them reaching the circulation in anything like the concentration in which they were absorbed. This capacity of the liver is but one expression of its *de*toxicating power in virtue of which it fixes many poisons, pathogenic toxins and others, and so prevents their entrance into the circulating blood.

There must therefore be constant interchanges between the living matter and the inorganic constituents of the lymph, for inorganic salts are being constantly absorbed and constantly execreted and so, on the whole, the percentage of inorganic constituents in the tissues does not vary. Now the amount of any one constituent—iron, calcium, sodium,

---

1. Macallum. A. B: J. Physiol., 22, 92, (1897-1898).

potassium, etc.—depends on its ionic pressure in the lymph as well as on the affinity for it possessed by the particular tissue in question. Certain forms of malnutrition may depend not so much on the malabsorption of an inorganic ion as on the diminished affinity for that substance as the result of some intoxication or devitalisation of the living tissues.

But even when an ion is present in the lymph in a concentration greatly above its concentration in the cell, that substance is not absorbed in anything like the degree which one would expect of it, if one had regard only to its concentration over iso-tonicity. The living tissues have a "power of refusal."

This explains what is so well recognized, that it is impossible to oversaturate the tissues with any of the mineral substances—iron, arsenic, calcium, or even oxygen. This fixedness of limit for saturation of protoplasm by chemical substances explains the impossibility of indefinite increase in bulk of tissues by overfeeding with nitrogenous food, of increasing the intensity of tissue-changes to any notable extent by the breathing of pure oxygen by healthy persons or of increasing, for instance, the iron or phosphorus content of the healthy red marrow or brain. After being satisfied, the tissues have a power of refusal—one of the expressions of "functional inertia."[1]

The same line of reasoning applies to the gases concerned in metabolism. Thus oxygen must be under a certain pressure in order to enter properly into union with the living matter. Whereas oxygen at the partial pressure of one-fifth of an atmosphere suffices for the perfusion fluid for a frog-heart, it must be under the pressure of one atmosphere in the fluid[2] necessary for the mammalian heart. In the actual blood, which could not take up anything like this quantity of oxygen in solution, this high pressure is functionally represented by the loose

1. Harris, D. Fraser: The functional inertia of living matter. London, Churchill 1908.

2. Ringer-Locke solution consists of—

$NaCl$, 0.9% $NaHCO_3$ 0.01 to 0.03%
$CaCl_2$, 0.024% Dextrose, 0.1%
KCl, 0.042%

Solution fed to the heart under the pressure of one atmosphere of oxygen.

chemical union of oxygen with the haemoglobin which dissociates in the neighbourhood of the living cells owing to the partial pressure of oxygen in them being always zero. In the lung-alveoli, oxygen is not present to more than 15 to 16% of an atmosphere (that is 104 mm of mercury), and this pressure of itself would be inadequate to drive the oxygen into solution in blood-plasma to an amount sufficient for the respiratory needs of the tissues, hence the blood possesses in its red corpuscles a substance capable of uniting with the inorganic oxygen in such a way that it can carry far more oxygen to the tissues than could ever possibly reach them in solution in a colloidal protein substance like the plasma. It is of advantage to the body that there be formed, therefore, complexes between proteins or protein-derivatives and certain inorganic ions; and Dr. Creighton,[1] by having studied some of these in detail, has thrown a good deal of light on their probable nature.

The whole of modern medicine is permeated by the notion that bioplasm is affectable, that is, is capable of responding to stimuli, a large number of which are chemical. Thus the formation of an *anti*-body is only possible because there is a reaction on the part of the affectable living matter to the chemical stimulus of the foreign substance: if toxin be the chemical stimulus, then antitoxin is the chemical response. But the toxin must first come into chemical union with the protoplasm else no antitoxin can result, just as the food molecule must come into chemical relationship with the protoplasm else no food could be absorbed.

The power of the proteins of blood-serum to absorb or take up either acids or alkalies is of fairly high importance to the bodily health. Thus, confining ourselves to the absorption of acids only, if we add normal acid to blood-serum and use methyl orange as an indicator, we shall have to add 0.18 c. c. of normal $\left(\frac{N}{1}\right)$ hydrochloric acid to turn the indicator pink. If now we titrate, similarly, the saline dialysate from the serum, the acid-

1. Creighton, H. J M. : loc. cit.

holding power is now only 0.04, so that (0.18 — 0.04) 0.14% is the figure representing the acid fixed by the proteins alone. This represents 0.51% of hydrochloric acid itself. Now this is rather a considerable amount; and its physiological significance is that, within pretty wide chemical limits, no free acid can reach the living tissues, for the circulating proteins can combine with them and so constitute a protective mechanism against acidosis or an excessively acid condition of blood. These native or serum-proteins, therefore, behave in an amphoteric fashion, for they can fix alkalies like acids and acids like alkalies. This explains how serum is acid to phenolphthalein, and alkaline to methyl-orange, while it is physico-chemically neutral. This double power proteins possess is now believed to be due to their polypeptide composition. This means that after any number of amino-acids have united together in chain fashion, there will be left an amidogen group at one end and a carboxyl group at the other, thus conferring a chemical polarity or what is otherwise called "residual affinity."

Thus the dipeptide glycyl-glycin is formed,

$$NH_2CH_2COOH + H\ NH\ CH_2\,COOH,$$

which gives us $NH_2CH_2.CO\text{-}NH\text{-}CH_2\text{-}COOH + H_2O$, a compound is basic on account of NH_2 and acidic on account of the COOH.

Hence owing to its acidity, glycin can form the copper salt thus

$$\left.\begin{matrix} CH_2\,NH_2\,CO\ O \\ CH_2\,NH_2\,CO\ O \end{matrix}\right> Cu$$

; and owing to its basicity it can unite with an acid like benzoic and form hippuric acid thus;

$$C_6H_5\ CO\ \overline{OH + H}\ NH\ CH_2\,COOH = C_6H_5\ CO\ NH\ CH_2\,COOH + H_2O.$$

The union of oxygen with haemoglobin is, however, not merely an adsorption due to residual affinities, for it is strictly mono-molecular, and the reduced form of the pigment is different from the oxidised in colour and therefore in spectrum.

But not merely are acids and inorganic substances united

to the native proteins of blood, for 1% of fat is probably held in a quite invisible form in blood-plasma. This is exceeded by the liver which can hold as much as 5% of fat in a perfectly transparent and invisible form; the fat, for the time being, is chemically united to the tissue-proteins. Some physiologists hold that during the time that carbohydrate is in the liver, it is present in a protein-complex and they say that glycogen can be demonstrated chemically in liver cells before it can be histologically.

One of the latest views as regards the early fatigue of muscle is that potassium salts are detatched and sent into the circulation depressing the motor nerve-endings. What unloosens the potassium is not yet obvious, but it appears that potassium is set free. Lactic acid is similarly free in the circulation in the later stages of muscular fatigue.

That the union is ionic as regards certain inorganic substances is interestingly shown in the part played by calcium salts in the clotting of the milk. It is known that when the rennin has transformed the caseinogen into soluble procasein there is no precipitation of the latter until it has formed a union with calcium: a drop or two of calcium chloride now causes an abundant precipitation of casein. In 1895 I showed[1] that barium chloride and strontium chloride were equally efficacious. Here the action must be due to the divalent ions and to the different ions indifferently, for certainly the anion chlorine is not the causal substance. Now while this is so as regards the clotting of milk, barium cannot supplant calcium medicinally. In particular, barium chloride cannot replace calcium chloride as regards efficiency in maintaining the heart's rhythm. Barium is absorbed very slowly from the intestine, and when so absorbed is found to be a direct stimulant of muscle-fibre as distinct from nerve-fibre. Just as barium can replace calcium in the clotting of milk so it can replace it in the clotting of blood. Magnesium sulphate injected into rabbits gives rise to

1 Harris, D. Fraser: Some points in the physiological chemistry and coagulations of milk. Pro. Roy. Soc. Edin., Session 1895-1896.

paralysis and anaesthesia and a low blood-pressure; it can be rapidly antagonised by either the chloride or the acetate of calcium, which revives the respiration in a surprisingly short time, but *not* by barium. It would seem as though in a non-vital union, barium and calcium were interchangeable, but not so in vital chemical complexes. Thus, the influence of magnesium is the same as that of calcium in inhibiting the spontaneous twitching of muscles immersed in solutions of sodium or lithium and in antagonising the contraction of skeletal muscle brought about by potassium salts; but in regard to its action on the heart, magnesium stands quite apart from calcium, barium and strontium, and is totally unable to replace these in the cardio-inhibitory mechanism or at the skeletal neuro-muscular junction.

And this is to a large extent comprehensible, for chemically, such substances as caseinogen, blood-germent, albumin, etc., and *not* to be taken as the equivalents of living matter, complicated as they are. The metabolism of calcium is full of lessons for us; one result of its presence in blood is to confer a certain degree of viscosity on that fluid. If there is too little viscosity, there is a tendency for the blood-plasma to exude too freely through the capillary wall so that an oedema or urticaria may be produced which is rapidly removed by the administration of a soluble salt of calcium—the chloride or lactate. It is possible that the tissues of haemophiles may suffer from a congenital inability to absorb or incorporate calcium. But indeed the whole doctrine of ionisation has been of great service in biology: for this may be taken to be the converse or the chemical condition of union of ions or atoms with the protein or living matter. Thus in the simple case of action of acids on living tissues, it is found that e. g. HCl is far more destructive to enzymes (except pepsin) than is acetic, the only satisfactory explanation of this being that HCl is far more perfectly ionised that acetic, not more than 3% of which is ionised. Since in regard to the effects of different acids, it is highly

unlikely that all the various anions (Cl, NO_3, PO_4, SO_4, CH_3COO) are the active substances, it is customary to attribute the physiological activity of the acids to the ionised H. Similary the alkalies, (KOH, NaOH, NH_4OH) have only the OH ion in common, so that their common influence in activating enzymes is to be attributed to the anion hydroxyl. Hence, too, the "free" alkalies are physiologically more active than the carbonates, because they are more perfectly ionized. In some recent work of mine[1] on the presumed endo-enzyme, tissue reduction, any inhibitory action I found as the result of the presence of protoplasmic poisons was to be attributed rather to their acidity than to their so called toxicity; this is but one more verification of the statement that acids—H ions— destroy enzymes. Of course in all these problems we are dealing with very small quantities: the maximum concentration for the activating effect of alkalies is not greater than $\frac{1}{10}$th molecular. May the activity of certain dilutions not explain some of the results obtained in homoeopathy?

So much, then, for the sign of the ionic charge; we have still to reckon with the valency of the ion or the potential of the charge or the ionic potential.

Now the physiological activity of inorganic ions increases with their valency thus—Na^{I}, Ca^{II}, Fe^{III}; sodium being more bland than calcium and calcium than iron or conversely, iron is more active (toxic) than calcium, and calcium than sodium.

Much interesting work on the physiological activity varying with the valency has been done by my friend Mr. Mines, Fellow of Sydney Sussex College, Cambridge. Speaking of the H ion Mr. Mines writes:

"Concentration of H ions from .005 normal upwards, cause strong tonic contraction in skeletal muscle and a primary rise in electrical irritability, while the trivalent cations produce neither of these effects. On the other hand, the H ion shows striking resemblances in its action to that of the K ion. The

1. Harris, D. Fraser: Bio-Chem. Journ., Vol. VI, 200 (1911).

relative concentrations of H and K needed to produce similar effects on frog's skeletal muscle are in the ratio of 1 to 5, i. e. inversely as their ionic velocities."

And again he writes:

"So far from it being possible to ascribe the physiological action of various ions to some one factor such as solution tension, valency or ionic velocity, it must be recognized that one and the same ion may exert its influence on different tissues by virtue of different characters or groups of characters. Further, two ions, which from the point of view of one tissue exhibit constellations of properties which are much alike, may present wholly dissimilar aspects towards another tissue."

Mr. Mines adopts the view that tissues are to be regarded as "emulsoid (hydrophile) colloids."

These and similar researches are of the utmost value in bringing us towards the biologist's great desideratum—greater definiteness of conception regarding the living matter itself.

Our present point of view is that not alone in terms of pure organic chemistry are conceptions of the constitution of protoplasm to be framed. We are finding we must include in these the non-organic, the non-vital substances whose presence does not indeed constitute life, but in whose absence life cannot be constituted. As we have had in the past full demonstation of the importance of the structurally "infinitely little," so at the present time we are having, each day, fresh demonstration of the importance of the chemically infinitely little.

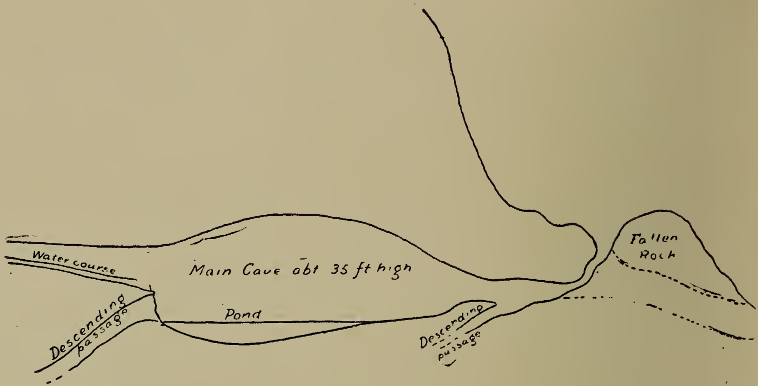
Dalhousie University, Halifax, Nova Scotia.
April 6th, 1912.

Report on Cave Examination in Hants County, N. S.—By Walter Henry Prest, Bedford, N S.

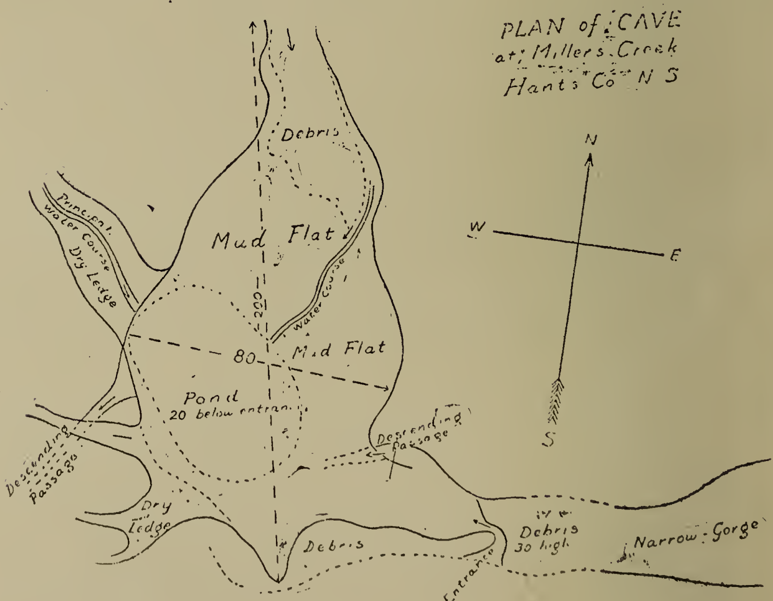
Read 13th November, 1911.

Having been asked by the council of the N. S. Institute of Science to make some investigations into the anthropological possibilities of the caves in Nova Scotia, I submit the following as the result of a few days' work. A visit to three of the caves of Hants County gave information that may be worth recording, though it does not bear very strongly on the purpose of my visit. These caves were: Miller's Creek Cave, Frenchman's Cave, and Five-mile River Cave, all within easy reach of town and railway.

Miller's Creek Cave.—This cave is about $4\frac{1}{4}$ miles north-eastward of the town of Windsor, Hants County, and about $1\frac{1}{4}$ miles north of the Midland railway. It is buried among steep hills near the headwaters of Miller's Creek, which here becomes only a dribble. A branch of the Miller's Creek road reaches the home of a man by the name of Connors, just back of whose house in the gulch in which is the cave. The original entrance is now nearly blocked by fallen rock, and the visitor is obliged to squeeze through a corkscrew-like hole in what was once the roof. Securing a guide, a lantern, and tools for use if the passage should be blocked, I entered an old quarry, at the end of which I climbed an immense pile of debris at the mouth of the cave. After sliding through the entrance backward, I found myself in a passage which had apparently once been about 30 feet wide and 15 feet high, but which is now choked almost to the roof by fallen rock. Descending to the level of the main cave the floor became more even and less littered with rubbish, and the roof higher. Then suddenly the cave expanded and a pond showed itself in the faint light of the



Miller Creek Cave
— Section —
from entrance to N W branch



lantern. The rest of the floor of the cave was covered with soft mud so deep and sticky that it was almost impossible to travel through it. It had evidenly been often overflowed, covering the sloping surfaces as well, with a coating of mud which made walking very difficult and insecure. The only dry ledges were on the southwest and northwest sides penetrated by small branches of the main cave.

The cave continued to the north, but was blocked to the roof in this direction by fallen rock. To the northwest was a smaller branch which probably penetrated farther than the others as it contained the main watercourse. I did not enter it as the ascent thereto was almost vertical and I was encumbered with the lantern. My guide refused to follow me farther than the entrance and I could not climb it alone. His conversation had been solely on ghosts and buried treasure and his absence was acceptable until this point was reached. The overflow from the pond, which was only 3 or 4 feet deep, was through a small slanting passage on the west side which descended to a lower level. The southern end of the cave, like the northern, was piled high with debris from the roof. Most of the branch passages were but from two to five feet high. The main cave is nearly 200 feet long, 80 feet wide, and probably 35 feet high in the centre. The annual freezing and thawing continually adds to the obstructions at the mouth of the cave and will in time doubtless make the entrance impassable. The inhabitants of the locality tell me that within their memory the passage was large enough to walk through upright.

I was convinced that the cave in its present condition never was a human habitation, though it may have been a refuge from storm or a hiding place from an enemy. However, when the land was higher the torrents may have kept the place cleaner, but just now the only places in the interior of the cave

that could furnish spots dry enough for habitation are the branch passages to the northwest and southwest. The extremely thin deposit on these ledges may perhaps yield human relics. The original entrance, now buried beneath from 20 to 30 feet of debris, would probably yield something of interest, though the cost of removal would be great.

Frenchman's Cave.—This cave is situated $\frac{3}{4}$ mile northeast from the village of St. Croix, Hants County, in the rough gypsum land to the east of the river.* This tract of land is full of sink-holes, some of which are now being formed to the detriment of the farms. One man spent much time trying to fill a newly formed hole with stones, but gave up the attempt after much labor. In the neighborhood of the cave it is hard to find a path among the numerous sink-holes, evidence of course of caves beneath. In one of these sink-holes is the entrance to the Frenchman's Cave, where it is claimed that the Acadian French hid their wives and children and buried their treasure in the days of Evangeline. Many other tales are connected with it, some based on fact but grossly exaggerated, some uncanny with superstition, and others simply ridiculous.

After travelling through a tract of very rough land, my guide led me down one of the numerous sink-holes, where at a depth of 35 feet we found the entrance to the cave. This was about 20 feet wide and 7 or 8 feet high and ran in a westerly direction. Its easterly extension was blocked by the fall of rock when the roof gave way. A large number of sink-holes farther east indicated its course. A small stream ran through the cave, which in rainy weather became a torrent, preventing entrance. I followed the cave about 150 feet, where it became only 2 feet high, becoming still less farther on. The bottom was small pebbles and mud. I was told afterward that one could penetrate several hundred feet to some larger rooms by crawling through on his stomach in dry weather.

* This cave is situated on the north bank of Wier Brook, a branch of the St. Croix River.

As a human habitation, even for the lowest savages, it seems to be out of consideration, owing to its susceptibility to floods, and the limited floor space above the water or mud level. It might, however, have furnished a refuge for a limited number of people for a short time. I therefore dismissed the idea that it had any archæological value in spite of the entertaining stories told about it.

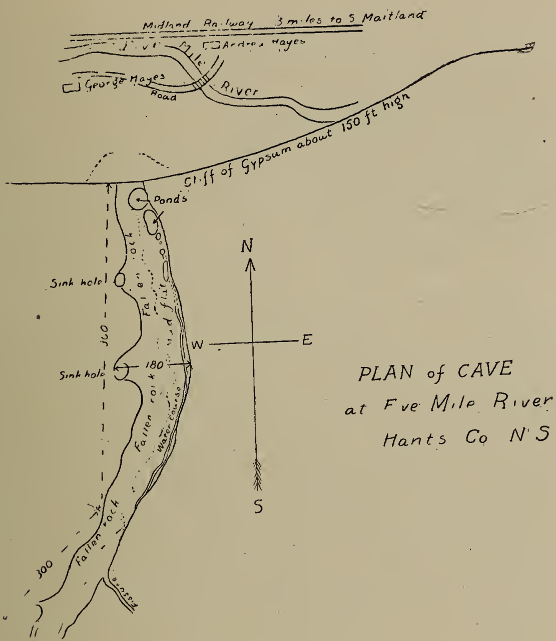
Five-mile River Cave.—This cave is situated in Hants County on the south bank of the Five-mile River, a western tributary of the Shubenacadie. It is $\frac{1}{6}$th mile south of the Midland railway, the nearest stations being South Maitland ($2\frac{5}{8}$ miles) and Burton's ($2\frac{1}{8}$ miles). The river, green hills, and towering white gypsum cliffs give a wildness and beauty to the surroundings not often seen outside Nova Scotia. Nearly half way up the pure white cliffs, is the mouth of the cavern. The mouth is wide and easy of access, being reached by an inclined plane of debris fallen from the cliff. It is, however, being slowly blocked up by rock as the fall of the friable and frost-riven gypsum is yearly adding to the obstruction. The entrance is probably 20 feet wide and 7 or 8 feet high, but the oldest inhabitants tell me that it once was over 20 feet high. The river, which once kept the face of the cliff clear, has long since been diverted to the opposite side of the narrow valley.

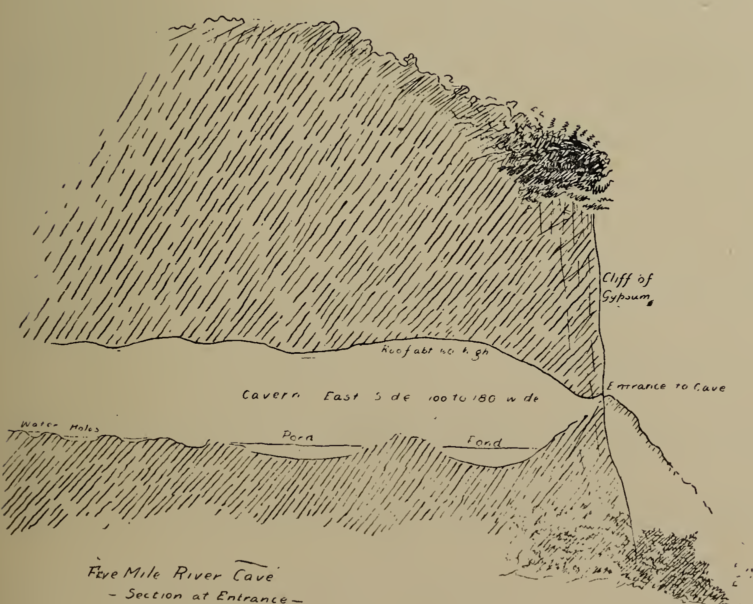
Procuring a guide and a couple of lanterns, I descended the pile of fallen rock at the entrance, and penetrated about 250 or 300 feet before lighting the lanterns. Here I stood beneath a vast dome over 150 feet wide and 60 feet high. On the left were several ponds and water-holes, deep and transparent, reaching to the wall. On the right was a slope of broken rock reaching to the right wall and almost to the roof. Proceeding, the lower part of the cave became muddy while the roof became higher and the cave wider. Near the first sink-hole it must have been nearly, if not quite 200 feet wide, and the white gypsum roof stretched almost flat, without a support, from one

side to the other. Great blocks of gypsum littered the floor and finally compelled us to climb over them or squeeze through, between, or beneath them. In climbing over the boulders, the guide fell and put one of our lanterns out of commission. In so large a cave this was a great inconvenience, as the narrow circle of light from the remaining lantern did not reach to either wall. The wide and slightly arched roof continued for over 1000 feet. Spreading from wall to wall without a single support it seemed to me a marvel of natural architecture. About 1300 feet from the entrance, the cave became so obstructed by enormous blocks of gypsum that a passage was hard to find. Many apertures were entered, followed a few yards, and retraced. Then others were followed up, down, or laterally. Some ended in diverging fissures, too small to be followed. The last, only 15 inches wide, ascended at an angle of 60° and became impassable. Even here the cave was large, but blocked from bottom to top by a jumble of fallen rock that prevented all further progress. The extreme length, as far as passable, is about 1600 feet.

The archæological value of this cave is much reduced by the enormous quantity of rock continually falling from the roof and cliff outside. In its original condition it was doubtless an ideal place for shelter, and was probably so used by the aborigines. Now there is probably 30 or 40 feet of debris over the original floor at the mouth of the cave. Probably nearly all the caves in the gypsum region are in the same condition, this friable rock rapidly crumbling under the influences of frost and heat.

Geological Conditions.—That the origin of these caves reached back to a time when this province was much higher than now, there is no doubt. Some evidence for this view is furnished by the springs that come up from the bottoms of rivers at tide-level, such as are seen in the River St. Croix above the bridge on the road leading from St. Croix to Brook-


Midland Railway 3 miles to S Maitland
George Hayes
Road
River
Cliff of Gypsum about 150 ft high
Ponds
Sink hole
Sink hole
180
300
N
W
E
S
PLAN of CAVE
at Five Mile River
Hants Co N S


Cliff of Gypsum
Entrance to Cave
Water Holes
Pond
Pond
Five Mile River Cave
– Section at Entrance –

lyn. In some places the gypsum is honeycombed with caves below the tide-level. Springs sometimes burst out in estuaries and tidal-flats as at Shubenacadie.

If we place the gypseous origin of the rock in question in the Triassic age, a time of great seismic disturbance, we have the whole of the long period since that time for the various phases of cave formation and destruction. There has been elevation, excavation, denudation (aerial and sub-aerial), and finally subsidence. A former covering of gypsum has been removed from a large tract of country, and former caves obliterated, now traceable only by narrow valleys or preciptuous gulches. Existing caves are located by strings of sink-holes, which latter are growing larger and more numerous as years go by. The gradual subsidence of the province has placed many of these caves beyond reach, and, according to the best evidence, this subsidence is still going on, unless it has very recently reached its lowest point. It may be mentioned that the three caves I have described, are located in formations of carboniferous limestone (the Windsor series).

A Rearrangement of Procedure for the Removal of Phosphate Ions from the Iron and Alkaline Earth Groups.—By Carleton Bell Nickerson, M. A., Instructor in Chemistry, Dalhousie University, Halifax, N. S.*

Read 8th April, 1912.

The following procedure is the result of several attempts to simplify the various methods in common use for the removal of phosphate ions during the qualitative separation of the metals of the iron and alkaline earth groups. It has been the author's experience that, for the usual college class in qualitative analysis, the methods commonly used require rather too much nicety in manipulation to be altogether practicable. The procedure given below has been used by the class in qualitative analysis at Dalhousie University this year with very favorable results.

1. *Procedure.*—Treat the solution (after the removal of all the metals precipitated by H_2S in acid solution) with a few drops of conc. HNO_3 and boil until all H_2S is expelled; filter if necessary. Add at once about ⅓ volume of strong NH_4Cl solution and a *slight* excess of NH_4OH. Filter:

Notes.—1. The HNO_3 is added to oxidize any iron that may be present, which after the H_2S treatment is always in the ferrous condition.

2. The treatment with HNO_3 may also cause a slight precipitation of sulphur from the H_2S.

3. Care must be taken to avoid adding more than a slight excess of NH_4OH, since the precipitate of $Al(OH)_3$ is somewhat soluble in an excess.

*Contributions from the Science Laboratories of Dalhousie University [Chemistry.]

3. The precipitate with NH_4OH under ordinary conditions would consist only of hydroxides of Fe, Al and Cr. If however PO_4''' ions are present, it may also contain phosphates of the above metals and also of Ca, Ba, Sr and Mg.

2. *Procedure.*—Dissolve a small portion of the NH_4OH precipitate in HNO_3 (Sp. g. 1.2) and test for PO_4''' ions with $(NH_4)_2MoO_4$. If a yellow precipitate forms, dissolve the remaining portion of the precipitate in dilute HCl (Sp. g. 1.12). Test a small portion of the solution for Fe with $K_4Fe(CN)_6$. To the remaining solution add $FeCl_3$ solution, drop by drop, until (after careful stirring), a drop of the solution removed by means of a stirring rod gives a *brown* precipitate of $Fe(OH)_3$ with NH_4OH on a porcelain plate.

Notes.—1. The test for Fe must be made at this point since $FeCl_3$ is added to the solution later on.

2. The addition of $FeCl_3$ causes a precipitation of $FePO_4$ (white) when the solution is made alkaline by NH_4OH. When a sufficient amount of $Fe^{\cdot\cdot\cdot}$ ions has been added to combine with all PO_4''' ions, an excess of $FeCl_3$ causes a precipitation of the brown $Fe(OH)_3$.

3. *Procedure.*—To the HCl solution containing an excess of $FeCl_3$ add NH_4Cl solution and a slight excess of NH_4OH. Filter. Save the filtrate.

Notes.—1. After the addition of NH_4OH, the precipitate will contain, $FePO_4$, and hydroxides of Fe, Cr, and Al, all the PO_4''' ions remaining in the precipitate. The filtrate may contain ions of Mn, Ni, Co, Ba, Sr, Ca, and Mg.

4. *Procedure.*—Dissolve the above precipitate in dilute HCl (Sp. g. 1.12) and add an excess of NaOH and H_2O_2 Filter.

Notes.—1. By the addition of NaOH and H_2O the $Al(OH)_3$ is converted into the soluble Na_3AlO_3, and the $Cr(OH)_3$ is oxidized to Na_2CrO_4, the iron precipitate remaining behind on the filter.

5. *Procedure.*—Divide the above solution into two parts, and to one add an excess of $HC_2H_3O_2$ and a few cc. of $Pb(C_2H_3O_2)_2$ solution. A yellow precipitate indicates Cr. To the other portion add an excess of dilute H Cl, and then a slight excess of NH_4OH. Warm and set aside. A white flocculent precipitate is $Al(OH)_3$.

6. *Treatment of filtrate from* 1.—Acidify a small portion of the solution with dilute HNO_3 and test for PO_4''' ions with $(NH_4)_2MoO_4$ If a yellow precipitate is formed, treat the remainder of the solution with H_2S. A white precipitate is ZnS. If no PO_4''' ions are found, see 7.

Notes.—1. The addition of even a slight excess of NH_4OH in 1, is sufficient to convert the Zn into the soluble complex compound $Zn(NH_3)_4(OH)_2$, which passes through into the filtrate and is removed by H_2S.

2. If the addition of $(NH_4)_2MoO_4$ shows the presence of PO_4''' ions, then the solution after the removal of Zn contains only the metals of the alkali group.

7. *Procedure.*—If PO_4''' ions are not found in 6, add solution to filtrate from 3, warm, and to the warm solution add an excess of H_2S. Filter:

Notes.—1. If PO_4''' ions are not found in 6, the solution will contain only those ions in excess of what was necessary to combine with the PO_4''' ions precipitated in 1. They may consist of: Zn, Mn, Ni, Co, Ba, Sr, Ca, Mg, K and Na.

8. *Procedure.*—Treat precipitate with a small amount of dilute H Cl (1 part H Cl 1.12 to 5 parts water). Residue may be Ni S and Co S. Separate in usual way. Treatment of

H Cl solution: Add an excess of Na O H. Filter and fuse the precipitate with Na_2CO_3 on platinum foil. Green color indicates Mn. To filtrate add H_2S. White precipitate is Zn S.

Notes.—1. An excess of NaOH forms a soluble compound with the Zn, Na_2ZnO_2, which passes into the filtrate. The Mn is at the same time precipitated as $Mn(OH)_2$ and converted by fusion with Na_2CO_3, to the compound Na_2MnO_4, which is green in color.

9. *Procedure.*—The filtrate from 7 now contains only the ions of the alkaline earth and alkali groups. These are separated and identified in the usual manner.

OUTLINE OF PROCESS.

To solution containing ions of Fe, Al, Cr, Mn, Ni, Co, Zn, PO_4, Ca, Ba, Sr, Mg, K, and Na, add NH_4OH. Filter:

Precipitate may consist of $Fe(OH)_3$, $Al(OH)_3$, $Cr(OH)_3$; also phosphates of: Fe, Al, Cr, Ni, Co, Mn, Ba, Sr, Ca, and Mg.

Dissolve a small portion in dil. HNO_3, and test for PO_4 ions with $(NH_4)_2MoO_4$.

Test another portion for Fe^{III} with $K_4Fe(CN)_6$.

If PO_4 ions are present: Dissolve ppt. in dil. HCl, remove PO_4 ions with $FeCl_3$, add NH_4Cl and NH_4OH. Filter.

- Ppt.:—$FePO_4$, $Fe(OH)_3$, $Al(OH)_3$, $Cr(OH)_3$. Dissolve in dil. HCl, add NaOH and H_2O_2. Filter:
  - Precipitate: $Fe(OH)_3$, $FePO_4$.
  - Filtrate: Na_3AlO_3 and Na_2CrO_4. Divide into two parts.
    - Acidify one part with $HC_2H_3O_2$, and add $Pb(C_2H_3O_2)_2$. Yellow ppt.: $PbCrO_4$
    - To the other part add first HCl and then a slight excess of NH_4OH. White ppt.: $Al(OH)_3$.
- Filtrate may contain ions of: Mn, Ni, Co, Ba, Sr, Ca, Mg. Combine with filtrate (*a*).

Filtrate may contain:

If PO_4 ions are not in excess—

(*a*) Ions of Ni, Co, Mn, Zn, Ba, Sr, Ca, Mg, K, Na, and NH_4. Add H_2S and filter.

- Precipitate may consist of: MnS, ZnS, NiS, CoS. Add dil. HCl (1 : 5) and filter.
  - Residue, NiS and CoS. Usual separation.
  - Filtrate contains ions of Mn and Zn. Add excess NaOH and filter.
    - Precipitate: $Mn(OH)_2$. Fuse with Na_2CO_3. Green coloration indicates Mn.
    - Filtrate contains Na_2ZnO_2. Add H_2S. White precipitate, ZnS.
- Filtrate contains only ions of the alkaline-earth group, and Mg. Separate and identify in the usual manner.

If PO_4 ions are in excess—[$(NH_4)_2MoO_4$ test]

(*b*) $Zn(NH_3)_4(OH)_2$ and ions of Na, K, and NH_4.

Pass in H_2S and filter.

- White precipitate, ZnS;
- Filtrate contains ions of alkali group, which may be separated and identified in the usual manner.

Brief Account of the Micmac Indians of Nova Scotia and their Remains.—By Harry Piers, Curator of the Provincial Museum of Nova Scotia, Halifax, N. S.

Read 8th January, 1912.

The following paper has been prepared for the purpose of presenting in a concise and systematic form some general information regarding the native tribe of Nova Scotia, and it is hoped it may be useful at least for ready references, as the writer does not know of anything dealing with the whole subject in just this way. He hopes at some future time to expand these brief notes into a paper which will deal with the subject more in retail. The bibliography which is appended, although not exhaustive, will assist in placing students in touch with most of the available sources of information.

Location.—The Indians of Nova Scotia belong to the Micmac tribe which is an important branch of the Algonquian family. Besides this province they inhabited Prince Edward Island, the northern part of New Brunswick and probably parts of southern and western Newfoundland. In New Brunswick they came in contact with the Malecite tribe, another branch of the same family, and in Newfoundland they occupy a region once inhabited by the extinct tribe of Beothuks, which latter is now regarded as a distinct family by itself.

Name.—The Micmacs call themselves *Megumawaach,* and the name Micmac evidently is a corruption of this.* J. N. B. Hewitt gives the meaning of *Migmak* to be 'allies'. The Micmac name for an Indian is *Ulnoo.* The French called the tribe *Souricois* or *Souriquois** (Champlain, 1603; Lescarbot, 1609);

* According to my notes made from the pronunciation of Chief Noel, the Micmac name for the tribe is *Meegamauk* and for any Indian, irrespective of tribe, *Ilanoo* or *Ilanoo(k).* Ilanoo or Ulnoo originally meant "a man" generally.

but among the English they have mostly been called Micmacs, and we find the name in use in 1696 (*N. Y. Doc. Col. Hist.*, ix., 643). Gatchet speaks of *Mikemak* (singular *Mikema*) as their Penobscot name. Malecites seem to have called them *Matu-es-wi skitchi-nu-uk,* meaning 'porcupine Indians', on account of their using porcupine quills in ornamental work (Chamberlain, Malecite MS., Bur. Am. Eth., 1882).

History.—The Micmacs seem to have been a fierce and warlike tribe, subsisting chiefly on the products of the chase. They soon became the loyal allies of the French who settled in Nova Scotia in the beginning of the seventeenth century, and there was more or less intermarriage between these settlers and the tribe, which more firmly cemented the bonds between them. When the English began to occupy Nova Scotia after the capture of Port Royal (Annapolis) in 1710 they found the Micmacs a great source of annoyance, as they naturally took the part of their old allies and lost no opportunity of harassing the British, and it was largely owing to their inroads that settlement of the country did not progress more rapidly. After the deportation of the Acadians and the fall of Quebec the English succeeded in making treaties with the tribe in 1760 and 1761, which permitted the clearing and settlement of the land to go on more peaceably than formerly, but it was not until 1779 that the disputes finally ceased, and from that time they could be spoken of as loyal to their new masters. Since then their history has been uneventful. Early in the nineteenth century a chief Indian commissioner (Monk) was appointed, and in 1842 an Indian commissioner (Howe) again held

*I am not quite certain of the derivation of the French name Souriquois. Des Brisay, (*History of Lunenburg*, 1st ed., p. 150), says the Micmacs were called by the French, "Souriquois, or salt-water men." The *Century Cyclopedia of Names* says the tribal name Souriquois, was one imitating words meaning "good canoe-men" (the derivation of which I fail to see, if from the Micmac language) ; and the same work, on what authority is not mentioned, states that *Micmac* is translated as "secrets-practicing men," alluding to Shamanistic jugglery. Surenne (*French Dictionary*) says *souriquois* is a term used to describe "a mixed tribe" ; and in Spiers and Surenne the definition is given *of mice, micy* ("peuple souriquois," *micy tribe*), but this probably has no connection with the use of the word to denote the Micmac tribe. The Beothuks called the Micmacs *Shanock,* "bad Indians," (*Journ. Anthrop. Inst.*, iv, 29, 1875.)

office in Nova Scotia, and was followed later by Col. Chearnley, but soon after confederation supervision was transferred to the Department of Indian Affairs at Ottawa.

Early Conditions.—In prehistoric times the Micmacs had made but slight advancement towards civilization, in this respect being behind some of the Indians of Ontario. They apparently did not cultivate Indian corn, but lived almost entirely by the chase and fishing, and delighted in war. In summer-time they dwelt mostly on the coasts and in winter retired to the more sheltered interior. They made various stone implements, canoes, snowshoes, a very few small copper implements, rough pottery (poorly burnt, with occasional attempts at rude ornamentation), and they produced some rude pictographs upon rocks. A few implements of unmistakable southern workmanship indicate that they traded somewhat with other tribes, although they may have been obtained by conquest.

Marc Lescarbot, who met with the Micmacs during his residence at Port Royal (Annapolis Royal) subsequent to 1606, gives in his *Nova Franciæ* (first published in 1609) an excellent account of the Souriquois as he found them in his day, and this description is one of the best of the earliest ones we have of their manners, customs, etc., at a period when iron implements were only just beginning to supplant those of stone. He says they wore a skin breech-cloth attached to a leather girdle, and a cloak of otter, beaver, moose or stag, bear or lynx, tied up with a leather thong, and one arm was usually thrust out. In their wigwams this cloak was laid aside, unless it was cold. The women wore a girdle about the cloak. In winter they wore "good brave sleeves, tied behind, which keep them very warm." In winter, going to sea, or hunting, they wore long leggings, cut into a great number of points on the side of the leg, and tied to the belt. On their feet they wore moccasins of moose-skin. They had no head-dress, but men and women wore their

hair loose over their shoulders, the men trussing it upon the crown of the head, some four fingers length, with a leather lace, which they let hang down behind. Lescarbot says, "All those I have seen have black hair, some excepted which have Abraham [auburn] color hair." They greased their bodies and anointed their shoulders with oil, to defend them from troublesome flies. They wore *matachias* hanging at their ears, and about their necks, bodies, arms, and legs. These the women made of porcupine quills dyed black, white and red. They more esteemed matachias made of shells by the Armouchiquois (Indians of New England), which were difficult to get owing to the continued wars between the tribes. Matachias of quills of glass, interspersed with tin or lead, were traded with them by the French. They passed their time in war or hunting, or making implements therefor, or in play. Their bows were strong and without fineness. Lescarbot marvels at how long and straight they could make their arrows with a stone when they had no metal knives, and these they feathered with feathers from the eagle's tail. Such as had traffic with the French headed the shaft with iron. They had quivers, and their bow-strings were made of intestines, and snowshoes or racquets were strung with the same material (Denys says with thongs of moose-hide). They also had wooden clubs "in the fashion of an abbot's staff" and shields which covered all their body. They bartered with the French for fishing lines and hooks. Canoes were made of birch-bark, and they "also make some of willows very properly which they cover with gum of the fir-tree." The French writer tells us that anciently they made earthen pots and also did till the ground, "but since that Frenchmen do bring with them kettles, beans, pease, bisket and other food, they are become slothful, and make no more account of these exercises." It was found by experiment that they had rather go without bread than have the trouble of grinding corn. The women peeled birch-trees for bark for their

wigwams, and labored at making canoes, etc., while the men "do play the gentleman, and have no care but in hunting, or of wars"; yet the women commonly love "their husbands more than the women of these our parts." Lescarbot once saw an Indian boil meat in a trough formed of a tree-trunk, into which he placed red-hot stones; and I may say that they also cooked thus in birch-bark receptacles. (See Relics of Stone Age, *Trans. N. S. Inst. Sc.,* ix, pp. 27-31). The missionary Biard, in his *Relation* of 1616, also gives an account of the Micmacs of his time, and states that they did not till the soil. The fullest account of their dress, manners and customs is to be found in Denys' *Description des Costes de l'Amerique septentrionale* of later date, 1672. (See Ganong's translation, 1908).

It is sometimes asked if Nova Scotian caves contain any evidence of having been occupied by prehistoric Micmacs or their predecessors. In order to investigate this question to some extent, an exploration was recently made of three gypsum caves in Hants county, but so far with negative results, although the large amount of rock debris in these caves would probably have hidden or obscured such evidence if it were there. (See Prest, *Trans. N. S. Inst. Sc.,* xiii, pp. 87-94).

No data is available regarding measurements of Micmac skulls, etc., whereby we might compare them with those of other tribes. There are ancient burial-places at Indian Gardens, Fairy Lake, etc., that would furnish material for such work. (See Prest, *ib.,* pp. 35-39).

Present Condition.—The Micmacs now live by acting as guides for sportsmen, and by making axe-handles, baskets, tubs, porcupine quill-work, and various odds and ends, and some of them cultivate a little land, having small houses on reservations but mostly going into conical birch-bark wigwams or "camps" as they are called, in the summer. Most of them have to eke out their slender means by asking alms. Birch-bark canoes are

now less frequently seen. They still occasionally make their own snowshoes. In the past they have been much decimated by smallpox, and consumption is prevalent among them, while drunkenness has been a great curse to them, but less so than formerly. The children when infants are strapped in a peculiarly shaped cradle, which is slung on the mother's back, or suspended from a tree. The children are taught obedience and respect to their parents. Women are accounted inferiors to the men.

Recent Dress.—Up to within comparatively recent years the men clothed themselves in a dark blue broadcloth coat ornamented with scarlet or other brightly-colored silk borders, scarlet cloth pipings in the seams, and elaborate coloured-beadwork extending across the upper part of the shoulders and on "wing"-like shoulder pieces, as well as on the cuffs and front boarder, and the coat was girded in by a red sash. With this were worn trousers of the same kind of cloth, with a row of narrow-cut tags up the outside seams. A high silk hat and low moose-hide moccasins completed the men's costume in those days. The chief and other officials still appear in such clothes (omitting the silk hat) on formal occasions, and the chief also at times of great ceremony wears a headdress of eagle-feathers. I am informed that the chief at Shubenacadie (?) has the equivalent of a "wampum" belt, which is hereditary in the office. I have not seen it, but it is described as being composed of various dark-coloured pierced stones strung on sinews or a leathern thong, and it is said to have some symbolic meaning, or tells some story, although there are few if any of the Indians who can now interpret it although some have an obscure idea of its signification.* Other heirlooms or insignia descending to each

*Reference to this belt is made on the authority of one Indian, and I have had no opportunity of verifying the statement which must be take with some doubt. Chief Noel never referred to the belt, although he showed me his other insignia of office. It was not among the chief's official effects which were forwarded to the Archbishop of Halifax on Noel's death in 1911. Dr. Rand, however, refers to a wampum belt on page 81 of his *Reading Book*, saying "as marked on the 'wampum belt,' [the chief's district of] Cape Breton is at the head." It is possible that the belt is in Cape Breton.

of the Shubenacadie chiefs, are a silver medal of 1814, presented by George III. to the then chief, and a large gilt medallion presented by a former Pope. The women formerly wore pointed cloth caps (*abedowargosen*) elaborately ornamented with coloured beadwork; loosely-fitting, brightly coloured satin jackets (*mardelit*) with red or other coloured borders bedecked with beads; and skirts of dark blue broadcloth prettily embellished on the lower parts with numerous broad horizontal bands of silk of various colours, in parts cut into pointed forms, and more sparingly ornamented with beads and spangles. Ornamental broadcloth leggings were also worn with the skirt. The older women are still sometimes seen in this characteristic costume, but it was once the regular dress of the women of the tribe. It may be observed that the pointed head-dress is depicted on old petroglyphs at Fairy Lake. (See Report on Provincial Museum for 1910).

Chiefs.—The province is divided into five districts, each of which has a chief, the one with which Halifax comes most in contact with being he at Shubenacadie. Rand (*Reading-book in Micmac,* 1875, p. 81) says the Indian name for the whole country, is *Megumaage* (Micmac-land), and he says it was divided into seven districts (including two in New Brunswick), each district having its own chief, but that the chief in Cape Breton, which comprehended one district, was looked upon as head of the whole. The seven districts as given by him were as follows: Cape Breton, Pictou, Memramcook (in New Brunswick), Restigouche (in New Brunswick), Eskegawaage (from Canso to Halifax), Shubenacadie, and Annapolis district reaching to Yarmouth. Chief John Noel of Shubenacadie informed me that the jurisdictions of the several chiefs in Nova Scotia are as follows: (1) The chief at Shubenacadie has jurisdiction over Halifax, Lunenburg, King's, Hants, Colchester and Cumberland counties, and he claimed that he was considered to be the head chief, perhaps the result of his having

been located nearest to the seat of the provincial government; (2) the chief at Bear River has jurisdiction over Annapolis, Digby, Yarmouth, Shelburne and Queens counties; (3) the chief at Pictou has control of Pictou county; (4) the chief at Pomquet presides over Antigonish and Guysborough counties; and (5) the chief at Eskasoni governs the whole of Cape Breton Island. Besides these there are chiefs in Prince Edward Island and in parts of New Brunswick. The chief has the settling of such disputes as may arise among the members of the tribe, and I do not know of an instance of an Indian bringing his case to one of our own courts. The chief is elected at a gathering of the tribe, much discrimination being exercised in the choice; and he receives a ratification of his appointment from the Governor, pledges allegiance to the Sovereign, and goes through a certain religious ceremony performed by the Roman Catholic Archbishop. Under the chiefs are captains and majors.

Reserves.—Throughout the province are certain areas of land reserved for Indian occupation. Some of these are so used for that purpose, others are not. Schools are located in some of the reserves.

Numbers.—Biard in 1611 places the number of Micmacs at from 3,000 to 3,500. In 1760 they were estimated at nearly 3,000, having dwindled by sickness. In 1766 we find them enumerated at 3,500. It may be noted that New Brunswick and Prince Edward Island then formed part of Nova Scotia. In 1842 Howe reported their number to be 1425. In 1851 they were returned as 1,056, which was probably an underestimate. The Nova Scotian census of 1861 (the first accurate one) gives the number as 1407. In 1871 they numbered 1,666 in this province; in 1881, 3,892, of which 2,125 lived in Nova Scotia; in 1884, 4,037, of which 2,197 lived in Nova Scotia; in 1892, 2,151 lived in Nova Scotia; in 1901, 1,542 were in Nova Scotia; and in 1904 (Indian Report) they numbered 3,861, of which 1,998 were in Nova Scotia, 992 in New Bruns-

wick, 579 in Quebec Province, and 292 in Prince Edward Island. In 1905, 1,993 were in Nova Scotia; in 1906, 2,148, and in 1911, 2,026.

Language.—The language of the Micmacs is a branch of that of the Algonquian tribe. William Jones of the Field Museum of Natural History, says that while their neighbours, the Abnaki, have close linguistic relations with the Algonquain tribes of the great lakes, the Micmacs seem to have almost as distant a relation to the group as the Algonquains of the plains. The Micmac, like many, if not all, of the native American languages, is remarkable for its copiousness, its regularity of declension and conjunction, its expressiveness, its simplicity of vocables, and its mellifluence. In all these particulars and others, it is said not to suffer from a comparison with the learned and polished languages of the world. One pecularity is that it is what philologists term holophrastic, a whole sentence being sometimes condensed into a single word. This, while it wonderfully shortens speech, greatly multiplies words. For example, Rand instances the sentence, "I am walking about, carrying a beautiful black umbrella over my head," comprising twelve words and twenty-one syllables, all of which can be expressed in a single Micmac word of ten syllables, *yale-oole-maktawe-pokose.* (See preface to Rand's *Dictionary*). The usual place for the accent is on the penultimate syllable, while a prolongued vowel is of course accented. Micmac words are extremely soft and melodious when pronounced by the Indian, being entirely without the harshness which results when a white man attempts to reproduce them, and even a dictionary tends to harshen them when they are represented by letters of our alphabet. It is this that has often made people think the language an uncouth one. The Micmac names of places are beautifully soft in sound and poetic in idea, and it is the greatest pity that we have not retained more of them instead of the meaningless European names we have too frequently scattered throughout the province. In such Micmac place-

names as we have kept, we have unfortunately greatly harshened the sounds, through our ears failing to appreciate the soft illusive sounds of the native's syllables. The late Dr. Silas T. Rand was the foremost student of the Micmac language, and he published a reading-book and a dictionary, as well as many biblical translations.

Religion.—We know practically nothing of assurance regarding their pre-historic religious beliefs, except that through legend we find that they paid high respect to and almost worshipped a superhuman being, in the form of an Indian, called *Glooscap.* He was benevolent, exercised a care over the Indians, was supposed to live in a wigwam, where an old woman kept house for him, and a small boy fairy was his servant. It was believed he could transform mortals and that he possessed other wonderful powers. He and his attributes are frequently mentioned in their legends, and the Indians suppose he is still in existence. (See Rand, *Legends of Micmacs,* p. xiv et seq.) Father LeClercq in the seventeenth century invented a series of hieroglyphs for use among the Micmacs, and these characters were employed in the printing of Micmac religious works by the Rev. C. Kauder. A page of LeClercq's Lord's Prayer in these characters is reproduced in Pilling's *Bibliography of the Algonquian Language,* opp. p. 305. In 1846 the Rev. S. T. Rand, a Baptist clergyman, took up the life of a missionary among the Indians, and as a result a Micmac Missionary Society was established, and Rand translated into the native language the greater part of the Bible. The official returns now give all the Micmacs as belonging to the Roman Catholic Church, the one with which they first came in contact about 1604, and to which they have since been firmly attached. They have an annual religious festival on St. Ann's day, which is perhaps less fully observed than in former years.

Legends.—They have a large amount of legendary lore relating to Glooscap, his followers, and various personified

animals, etc., all of great interest, which has been collected in Rev. S. T. Rand's *Legends of the Micmacs* (New York and Lond., 1894), to which I must refer those interested in this very attractive subject.

Mortuary Customs.—Since the advent of Europeans, at least, the Micmacs have buried their dead in the ground, although I was told by Chief Noel* and other Indians, that in prehistoric times (perhaps under certain circumstances) they placed the corpse, wrapped up, in a tree or on a staging, and I find that Denys (page 438 of Ganong's edition) confirms this tradition and describes in detail their old burial customs. Unfortunately, no proper scientific examination has yet been made of pre-historic burials, to ascertain exactly the manner of burial, although Dr. Patterson has a few words to say regarding this subject (*Trans. N. S. Ins. Nat. Sc.*, vii, p. 231 *et seq.*). There is no doubt, however, from such old graves as have been opened, that various implements and utensils were placed along with the dead.

Games.—Some games survive from pre-historic times. One of them, the most popular, is known as Indian dice (*altestakun*) and is played with six bone or walrus-ivory disks, flat on the upper side and slightly convex on the other, inscribed with characteristic curved lines, forming a figure resembling a star or Maltese cross, for ornamental or symbolic purposes. These are tossed on a shallow wooden platter, and according to the result the player gets little stick counters, of which there are 55 in all, a few of which (of greater value than the rest) are of different shape from the remainder. A similar game

*Since this paper was written, John Noel, the venerable chief of the Micmacs of Halifax, Lunenburg, King's, Hants, Colchester and Cumberland counties, died at the Indian reservation on Spring Brook, near Shubenacadie, on 20th May, 1911. He had been born at Pictou on 3rd May, 1829. He was highly esteemed by the tribe over which he presided and by the white men with whom he came in contact. He had always taken interest in matters relating to his people's history, and the writer is indebted to him for valuable tribal tradition and other information and recalls with pleasure many hours spent in conversation with him on such topics. Noel had succeeded his stepfather Chief James Paul, who had probably succeeded his uncle Francis Paul, who had succeeded Chief Samuel Paul (also known as Benjamin Paul).

(*wabanokank*) is played with eight slightly larger disks of like form and ornamentation, which are tossed by the hand upon a spread blanket or cloth. Still another game (*comugesjokonk,* i.e. "to play little sticks") is almost the counterpart of the European game of jack-straws, and may be of European origin, although the Indians themselves claim it as a native game.

Pre-historic Implements.—There are only two important collections of Nova Scotian Indian relics of the stone age. The principal one is in the Provincial Museum of Nova Scotia, Halifax, and embraces (*a*) miscellaneous implements and other relics deposited therein since 1831; (*b*) the collection of the late Judge M. B. DesBrisay, of Bridgewater, N. S.; (*c*) the collection of the late C. W. Fairbanks; and (*d*) the collection of the late Dr. W. Webster. The total number of specimens in these four collections is now 1287. The next largest collection is that of the late Rev. Dr. Geo. Patterson, of New Glasgow, N. S., presented by him to Dalhousie College, Halifax, and containing about 250 specimens. There are also several other specimens there, donated by the late Dr. Thomas McCulloch. All of these have been described except the DesBrisay collection.

Relics of the stone age are uncommon in Nova Scotia, in marked contrast to the large number that are found in Ontario and to the south, and this no doubt indicates that Nova Scotia had been occupied for a much shorter period than those parts, or that the inhabitants were much fewer for the area.

Another point to which I desire to draw attention is the great probability that many of the implements found in this province are really remains of a period when the country was occupied by Eskimo. Tradition affirms that the Micmacs coming from the southward drove the Eskimo northward, and this is borne out by evidence obtained from the implements. Among the Algonquians, to which family the Micmacs belong, the axe-method of hafting was common, and to the south axes

are frequently found and form a fair proportion of the implements met with in collections. In this province, on the contrary, stone grooved-axes are rare; and in their places we find an unusual number of adze-shaped implements, intended to be hafted as adzes. Now, this latter method of hafting is very prevalent among the Eskimo, so much so that they have taken a modern steel hatchet, drawn the handle, and with much pains hafted it as an adze. I believe, as pointed out in a paper printed in volume ix of the *Transactions of the N. S. Institute of Science,* that we have in this province, as indicated above, remains of a previous settlement by the Eskimo, and we must with great caution speak of the stone implements of Nova Scotia as Micmac.* In subsequent remarks, I will speak generally of these implements, without attempting to distinguish between those that may be truly Micmac in origin and those that may be Eskimo. When I use the expression "common" in regard to a certain form of implement, the expression is a relative one in comparison with other aboriginal relics in this province, and does not compare with the abundance of an implement that might be termed common in a region where such relics are far more numerous than here. It may be mentioned that so far no implements that can be fairly called palæolithic have been found in Nova Scotia, nor under circumstances that would lead to their being so considered, and we must regard all remains here as belonging to the neolithic age.

Arrow-heads are common and are nearly always of some siliceous stone, mostly jaspideous, such as are found *in situ* in the western parts of the province. They are of various sizes, from less than an inch to the larger size which grades into the so-called spear-head. They are of various forms: leaf-shaped, notched, and stemmed. Some of these were no doubt actually hafted and used as knives, particularly the larger leaf-shaped ones. The site of an arrow-maker's workplace was discovered

*See also Patterson, *Trans. Inst. Nat. Sc.*, vii, pp. 236-237.

a number of years ago at Bachman's Beach, near Lunenburg, and furnished a large number of specimens, including many chips and some heads not completed.

Of so-called *spear-heads* there are a much lesser number. Many of these were probably cutting implements or knives, as also some of the larger arrow-heads as before mentioned. Otherwise we fail to find the aborigine's stone knife, an implement that must have been common among them. Lescarbot makes no mention whatever of spears as in use in his day, although he describes their various other weapons (see previous pages). Denys, however, frequently mentions spears, headed with bone, as in use among the tribe, and also knives of bone. There have been found at Milton, Queen's County, a few long, polished slate implements, like poniard blades, one of which is 18 inches long and tapers regularly from 1.75 inch in width at the base to about .75 of an inch near the end, where it suddenly diminishes to a point. These could only have been ceremonial implements, such as the long delicate blades found in California, as their fragile nature would forbid any rough usage, such as that of war or sport.

While referring to the cutting implements of our Indians, it may be mentioned that the Micmacs at the present time and for as long as is in the memory of man, have exclusively used in woodworking, etc., a peculiarly-shaped knife (somewhat like that of a farrier), the blade of which is made by themselves from an old file, which they invariably use by drawing towards them. This strong preference for a drawing cut, instead of one directed away from the body as is the manner among Europeans, is without doubt of pre-historic origin, and is worthy of attention from anthropologists, as possibly having some connection with the similar preference for a drawing cut which is evidenced by some east Asiatic peoples. Reference will be also made to the prevalence here of draw-cut stone implements such as the adze, which I think indicates the former presence or influence of the Eskimo.

Adzes or "celts" are common, in fact with the exception of arrow-heads are the most abundant relics found. They are nearly all unmistakable adzes, with one side more or less flattened, and intended for a drawing-cut with the edge at a right angle to the haft. It is this marked prevalence of the adze that leads me to believe that these are largely the remains of an earlier occupancy of the country by Eskimo, the more typical Algonquian (Micmac) implement, the true grooved-axe, being very rare, and indicating a briefer occupancy by the latter tribe. Fuller particulars on this subject will be found in my paper, "Relics of the Stone Age in Nova Scotia," *Trans. N. S. Inst. Sc.*, vol. ix, pp. 36 *et seq.* These adzes are mostly more or less slender, although some are only about twice as long as broad. Nearly all are neatly and systematically formed from pecked and polished stone, such as quartzite, hard slate, etc., while one is of sandstone. A few are very roughly chipped into form, somewhat palæolithic in appearance, but may not have been completed.

I can find nothing that I would care to strictly designate a *chisel.*

Gouges are common, and are formed of similar material to that of the adzes, into which they somewhat intergrade. In some the groove is almost indistinguishable, and is confined to the vicinity of the cutting edge. Others have a well defined, deep groove extending about half the length, and others have a deep groove extending the whole length. The last seems to be a distinct implement from the others. Gouges are somewhat adze-like in side outline, and those with the groove extending half the length were undoubtedly hafted as adzes.

Grooved axes, as before mentioned, are rare in Nova Scotia. The Patterson collection contains only one specimen, while there are ten in the Provincial Museum (namely, two in the general collection, six in the DesBrisay collection, and two in the Fairbanks collection). One of those in the Museum is

double-grooved, and in this respect it is unique in this province. They are well formed from water-worn oval quartzite boulders with the groove and edge "pecked" into shape. The grooves completely encircle the implement.

Hammer- (or club-) heads are very rare. I have only seem two—one in the DesBrisay collection in the Provincial Museum and one in my own possession. The latter was dug up at Dartmouth, and is neatly formed from an egg-shaped quartzite boulder, 3.50 inches long, entirely encircled by a pecked groove for the purpose of lashing it to a handle. It was no doubt used as a weapon, and the present Indians have a tradition that such hammers on occasions were thrown at an enemy and I have heard them say that a man could be thus struck with them when he was sheltered by a tree, attributing this to some magic properties of the weapon. The experiment might be tried to see if when hurled they can be made to take a laterally curved trajectory, somewhat after the manner of a boomerang, although the symmetry of the hammer would make it seemingly impossible for it to do so.

Pendants or "sinkers" are rare. Two are in the Patterson collection, and nine are in the Provincial Museum (namely, seven in the DesBrisay collection and two in the Fairbanks collection). Dr. J. B. Gilpin figured one, and I have seen one belonging to the late W. C. Silver, of Halifax; a total of thirteen. All are carefully fashioned, of graceful outline, and while of the same general appearance, differ very much in detail of form. None have a hole for suspension, but they have a little knob on top. I do not believe they were used as sinkers, as they are far more elaborately wrought than would be necessary for such a purpose. More likely they were used in some way as charm-stones, or in some religious ceremony, and I think I have heard Chief Noel affirm that they were employed as a charm to bring fish to a fishing place, while there are Indians who believe they were used as "sling-shots." Perhaps

the best explanation, to my mind, of their use, was given me by an Indian who says that years ago a very old Micmac woman informed him that they were employed as whorls in spinning thread from beaver's fur to make cloth in which to encircle a couple at the conclusion of the marriage ceremony in pre-historic times.

Pipes are somewhat rare. Sixteen are in the collections referred to; namely, three complete ones and one incomplete in the Patterson collection; and twelve in the Provincial Museum (seven complete ones, one of which is probably of European manufacture for barter, and one in process of manufacture, in the general collection; and three complete and one under construction in the DesBrisay collection). Besides these there is an old pewter pipe such as was used in barter by the early traders.

What is considered as the typical Micmac pipe has a pear- or barrel-shaped bowl upon a keel-shaped base, the latter with one or more holes to suspend it about the neck to prevent loss. A remarkable example in the Provincial Museum has bowl and stem in one piece, the former with a boldly executed carving of a lizard with a tail lying along the lower surface of the stem. The whole pipe is about seven inches long, and it is formed of a light grey pipestone, finely polished. It was discovered near Upper Rawdon in 1870 with some iron implements, etc. In this part of the Dominion it is unique, and is doubtless not the work of Micmacs, but must have been secured by trade or conquest.* A pipe almost identical in form has been found in Pennsylvania (Dr. Rau) and a similar one in Ontario (D. Boyle). Another remarkable pipe was found at Musquodoboit, Halifax County, and is of the typical mound-builder's form, with flattened base, and like the preceding one must have been

*I cannot agree with Dr. Ganong (Denys, p. 424, note) that this may be of Micmac manufacture. Denys (p. 421) mentions stone pipes with bowl and stem in one piece; and probably one from LaHave, N. S., in the DesBrisay collection, is such a one as the old writer refers to.

brought into this country as it is entirely un-Micmac in character. More-modern Micmac stone pipes, formed with steel tools, are ornamented with incised circles and lines, a style of ornamentation still prevalent in Micmac work of various kinds.

A few *pierced tablets* (flat, polished slate stones, with one or two small round holes in them) are in the Provincial Museum, and the Patterson collection contains one. They have been supposed by some to have been used in shaping bowstrings, but their use here, as elsewhere, is obscure.

Two snake-shaped *rings* of white limestone, probably artificial, are in the Provincial Museum, and if of man's workmanship, must have been charm-stones, possibly connected with snake-worship.

Portions of two long *stone tubes* (just such as have been described by Schoolcraft from the Ohio mounds) were found many years ago at Dartmouth and are now in our Museum. They are of similar stone to that of the lizard pipe previously described. They show very great skill in manufacture. One end is entirely open, while the other has but a small hole in it. Various theories have been advanced as to the use of such implements were found in America. The Micmac chief, John Noel, told me that tradition says they were used, in the manner of a syringe, for administering a medicated solution per rectum. This is at least a novel explanation, and is noted for what it may be worth.

Some pieces of worked *copper* have been found, consisting of hammered nuggets of native copper, rough knife-shaped implements, and piercers; all made from the native copper of the trap of the Bay of Fundy.

Bone implements are uncommon, but there are several specimens in the Provincial Museum and the Patterson collection, namely, piercers, fish-spears, ivory harpoon-points (similar to those used by the Eskimo) and pieces of walrus ivory.

Two strings of *shell wampum* are in the Provincial Museum, and were doubtless brought into the province by barter with the Indians of New England, as Lescarbot mentions.

A considerable quantity of *pottery* has been found at various places throughout the province, some being ornamented by impressions of twisted cords, oblique dashes, crescent-shaped impressions, zig-zag rows of small square dots, etc. Some of the pots at least have been obtusely pointed on the bottom.

Of *relics of European manufacture* obtained by the Indians by barter, we find iron or steel axes and tomahawks, spear-heads, knives, kettles, metal pipes, glass beads, etc.

Kitchen-middens.—Kitchen-middens have been met with in various parts of the Nova Scotian coast and on rivers and lakes, such as would be favorite camping grounds in the past. They furnish shells, bones, implements, pottery, and various camp refuse. Gossip described the opening of some (*Trans. N. S. Inst. Nat. Sc.,* i, pt. 2, 94-99), and Patterson also refers to a number of locations (ib., vii, 237 *et seq.*), but none seem to have been opened and examined with the thorough scientific care which is now usually devoted elsewhere to such investigations.

Mounds.—Nothing resembling mounds has yet been discovered in the province.

Petroglyphs.—At Fairy Lake or Kojimkoojik ("swelled parts)", on the upper waters of the Liverpool River, are many very interesting incised drawings on slate, doubtless the work of Indians, in some parts with superimposed drawings of much later date, probably the work of woodsmen. Similar drawings are found at George's Lake (near Kojimkoojik) and on Port Medway River, all in Queen's county. 331 sheets of tracings of the oldest of these drawings, made by the late Geo. Creed in 1887 and 1888, are preserved in the Provincial Museum. (See Creed's unpublished paper mentioned in the bibliography; also *Report of Provincial Museum for* 1910, as well as *10th Ann. Report of Bureau of Ethnology for* 1888-89, Wash., pp. 37-42).

BIBLIOGRAPHY.

(The following is a fairly complete list of works treating of the Micmac tribe. Information on the subject may also be obtained in the Reports of the Indian Commissioner in the earlier volumes of the Journals of the N. S. Assembly, and also in the Reports of the Department of Indian Affairs, Ottawa, since 1867.)

1598. **Cartier (Jacques).**—Discours du Voyage aux Terres neufves de Canada. Paris, 1598.— Cartier's first voyage was made in 1534, but he makes but a mere mention of our Indians.

1609. **Lescarbot (Marc).**—Nova Francia. Lond., 1609.— Also later editions, and recently republished by the Champlain Society, Toronto, 1907, to be in three volumes. Also in the original French, Paris, 1609. Contains interesting account of the Micmacs of that early period. Lescarbot went to Port Royal (Annapolis) in July, 1606.

1616. **Biard (Père Pierre).**—Relation de la Nouvelle France. Lyons, 1616.— See Thwaite's edition, Jesuit Relations, vols. iii and iv.

1632. **Champlain (Samuel de).**—Les Voyages de la Nouvelle France occidentale, 1603-1629. Paris, 1632.— Also subsequent editions. Gives short account of hunting and burial customs.

1672. **Denys ([Nicholas]).**—Description geographique et historique des Costes de l'Amerique septentrionale. Avec l'Histoire naturelle du Pais. 2 vols. Paris, 1672.— The second vol. ('Histoire naturelle des peuples,' etc.), chap. 23-24, treats very fully of the Indians (Micmacs). See the very fine annotated translation by Dr. W. F. Ganong, with original text, published by the Champlain Society, Toronto, 1908. This work contains very much that is of the greatest interest to those studying the early customs, etc., of the Micmacs of Nova Scotia.

1691. **Le Clercq (Père Christien).**—Novelle Relation de la Gaspesie. Paris, 1691. 572 pp.— Contains much concerning the Micmacs of Gaspe Bay, Quebec Province, whom he calls Gaspesiens. Le Clercq invented the hieroglyphs, still in use among the Micmacs, some of whom write and read them, and in which Kauder printed his catechism at Vienna; see 1866.

1758. [**Maillard** (Abbé **Anthony S.**)].—Account of the Customs and Manners of the Micmakis and Maricheets, Savage Nations, now dependent on the Government of Cape Breton. By a French Abbott. Lond., 1758. 138 pp.

1815. **Bromley (Walter).**—Two addresses on the Deplorable State of the Indians; one delivered August 3, 1813, the other March 8, 1814, at Halifax. (Published for the benefit of the Indians). London, 1815. 71 pp.

1820. **Bromley (Walter).**—An appeal to the virtue and good sense of the inhabitants of Great Britain, in behalf of the Indians of North America. Halifax, 1820. 57 pp.

1823-25. [**Bromley (Walter)**].—A General Description of Nova Scotia. [Anon.] Halifax, 1823. New edition: Halifax, 1825. 200 pp.— Chapter v. (pp. 44-58) deals with "The Indians (two tribes), attacks on Canso, treaty, customs, manners, civilization, and specimens of their language." Bromley, who was on the half-pay of the 23rd Regiment of Foot, established the Acadian School at Halifax on 31st July, 1813, and took a deep interest in the Micmacs, their customs, language, etc., he being apparently the first Englishman to do so to any extent.

1827. **West (John).**—Journal of a Mission to the Indians of the British Provinces of New Brunswick and Nova Scotia, and the Mohawks on Grand River, Upper Canada. Lond., 1827.

1829. **Haliburton** (Judge **Thomas Chandler**).—Historical and Statistical Account of Nova Scotia. 2 vols. Halifax, 1829.— Contains miscellaneous historical references to Micmacs.

1836. **Bromley (Walter).**—Vocabulary of the Micmacs. In Gallatin (A.), Synopsis of Indian Tribes, in Am. Ant. Soc. Trans., vol. ii, pp. 305-367. Cambridge, Mass., 1836.

1850. **Rand** (Rev. **Silas Tertius**).—A Short Statement of Facts relating to the History, Manners, Customs, Language, and Literature of the Micmac Tribe of Indians in Nova Scotia and P. E. Island. Halifax, N. S., 1850. 40 pp.— This is a most valuable account of our modern Micmacs, written by one whose knowledge of them was very intimate. See also 1894.

1850. [**Rand (Rev. Silas Tertius)**].—The History of Poor Sarah; a pious Indian woman. In Micmac. [Halifax (?), 1850.]. 12 pp.

1853. [**Rand (Rev. Silas Tertius)**].—The Gospel according to St. Matthew in the Micmac Language. Charlottetown, 1853. 118 pp.— Also as Pela Kesagunoodumumkawa tan tula Uksakumamenos Westowoolkw Sasoogoole Clistawit ootenink; Megumoweesimk; Chebooktook [Halifax], 1871; sometimes with almost the entire New Testament.

Rand subsequently published, anonymously, Micmac translations of the Bible as follows, and later editions of the same, which will be found fully set forth in Pilling's Bibliography:—St. John (Halifax, 1854, 95 pp.); St. Luke (Bath, 1856, 148 pp.); Genesis (Bath, 1857, 213 pp.); Psalms (Bath, 1859, 282 pp.); Acts (Bath, 1863, 140 pp.); Exodus (Halifax, 1870, 166 pp.); St. Mark (Halifax, 1874, [39 pp.]); Epistles and Revelation (Halifax, 1874, [216 pp.]). Also, with his name, The Gospels of St. Matthew, Mark, and Luke, with the Epistles and Revelation, translated from the Greek into Micmac; Halifax, 1875; 126+[39]+[68]+[216] pp.

1854. **Rand (Rev. Silas Tertius)**.—Ferst Reding Buk in Mikmak. London, 1854. 40 pp.— For second edition, see 1875.

1861. [**Shea (John Gilmary)**].—Micmac or Recollect Hieroglyphics. Historical Magazine, 1st series, vol. v, pp. 289-292; New York and London, 1861.— A general account of the invention of these symbols by LeClercq, and their use, also the Lord's Prayer in hieroglyphs.

1864. **Ambrose (Rev. John, M. A.)**.—Some account of the Petral ... with a few observations on a beach-mound or kitchen-midden, near French Village. Trans. N. S. Institute of Natural Science, i, pt. 2, pp. 34-44. Read 4 Jan. 1864.— Kitchen-middens described on pages 42-43.

1864. **G[ossip] (W[illiam])**.—On the occurrence of the Kjockken-moedding, on the shores of Nova Scotia [at French Village and Cole Harbour, Halifax Co.]. Trans. N. S. Inst. Nat. Sc., i, pt. 2, pp. 94-99.

1864. **Maillard (Abbé [Anthony S.])**.—Grammar of the Mikmaque Language of Nova Scotia, from the manuscripts of the Abbé Maillard. New York, 1864. 101 pp.— (Vol. 9 of Shea's Library of American Linguistics.)

1865. **Murdoch (Beamish).**—History of Nova Scotia. 3 vols. Halifax, 1865-7.— Contains miscellaneous historical references to the Micmacs.

1865. **Uniacke (Rev. Richard J[ohn]).**—Sketches of Cape Breton, originally addressed as letters to Archbishop Whately. Preface dated, Sydney, C. B., 12 Sept., 1865, but originally written about 1862. Unpublished (?) manuscript in files of N. S. Historical Society.—Chapter 8 (20 pp.) is on the "Native Indians."

1866. **[Kauder (Rev. Christian)** of Tracadie, N. S.].—Buch des gut enthaltend den Katechismus, Betrachtung, Gesang. Wien, [Vienna], 1866. 146+110+210 pp.— Catechism, meditations and hymns, printed in the Micmac hieroglyphics invented by Father Christien Leclercq, which had previously only been used in manuscripts. Each of the parts of this book were also published separately; same place and date.

1868. **Dawson ([Sir] John William).**—Acadian Geology. 2nd ed. London, 1868.— Pp. 41-46 of chapter 4, contains remarks on prehistoric man in Nova Scotia; and Micmac heads are figured opp. p. 41, and a few stone implements on p. 43. Appendix A, pp. 673-675, is on the Micmac language and superstitions.

1869. **Akins (Thomas B[eamish],** D. C. L.).—Selections from Public Documents of Nova Scotia. Halifax, 1869.— Miscellaneous historical references to Micmacs, text of treaties, etc.

1870. **DesBrisay (Mather B[yles],** M. P. P.).—History of County of Lunenburg. [1st ed.] Halifax, 1870.— The aborigines are dealt with on pp. 150-159. See also enlarged 2nd ed., 1895.

1871. **[Rand (Rev. Silas Tertius)].**—[Terms of Relationship of the Micmacs, and Etchemins or Malisetes, collected by Rev. S. T. Rand, missionary, Hantsport, N. S.] In Morgan (Lewis Henry), Systems of Consanguinity and Affinity of the Human Family, (Smithsonian Contributions to Knowledge, vol. 17, no. 218), pp. 293-382, lines 59-60; Washington, 1871.

1873. **Gilpin (J[ohn] Bernard,** M. D.).—On the Stone Age of Nova Scotia. Trans. N. S. Inst. Nat. Sc., iii, pp. 220-231, with plate illustrating 10 specimens. Read 10th Feb., 1873.

1873. Rand (Rev. Silas Tertius).—Short Account of the Lord's Work among the Micmac Indians. Halifax, 1873. 32 pp.

1873. Campbell (Duncan).—Nova Scotia. Montreal, 1873.— Pp. 17-26 treats of the Micmacs, the information having been evidently derived from Rand's Short Statement of Facts.

1875. [Rand (Rev. Silas Tertius, D. D.)].—A First Reading Book in the Micmac Language. Halifax, 1875. iv, 5-108 pp.— This is a most necessary book for anyone studying the Micmac language. See also 1854.

1877. Gilpin (J[ohn] Bernard, M. D.).—Indians of Nova Scotia. Trans. N. S. Inst. Nat. Sc., iv, pp. 260-281. Read 12 March, 1877.— Treats, in a most interesting manner, of the Micmacs in historic time.

1877. Patterson (Rev. George, D. D.).—History of County of Pictou, N. S. Montreal, 1877.— Pp. 26-37 is devoted to an account of the Micmacs.

1878. Dawson (Sir John William).—Supplement to second edition of Acadian Geology. London, 1878.— Additional matter on Micmac remains is given on pp. 18-19, with figure of a bone harpoon-head on p. 19.

1883. Patterson (Rev. George, D. D.).—Antiquities of Nova Scotia. Annual Report Smithsonian Inst. for 1881. Wash., 1883, pp. 673-677.

1884. Leland (Charles G[odfrey]).—Algonquin Legends. Bost., 1884. 377 pp., illus.— Founded chiefly on the legends collected by Rand. See 1894.

1885. Rand (Rev. Silas Tertius).—The Micmac Language. In Canadian Science Monthly, Nos. 10-11, pp. 142-146; Kentville, N. S., Oct.-Nov., 1885.— A general discussion, including some polysynthetic words.

1888. Rand (Rev. Silas Tertius, D. D., LL. D.).—Dictionary of the Language of the Micmac Indians. Halifax, 1888. viii, 286 pp.— English-Micmac part only published, but the Micmac-English section is in manuscript.

1888. Rand (Rev. Silas Tertius).—The Micmac Indians. Our Forest Children, vol. ii, no. 4, pp. 10-12; Shingwauk Home, Sault Ste. Marie, Ont., 1888.— Grammatic remarks, p. 11; vocabulary of about 80 words and sentences, Micmac and English, pp. 11-12; etc.

1888. Creed (George).—Pictographs at Fairy Lake, Queens Co., N. S. Read before Nova Scotia Historical Society, 13th November, 1888, but not published entire. A very full summary of it appears in the Morning Chronicle (newspaper), Halifax, of 14th November, 1888.— 331 sheets of the copies of the petroglyphs made by Creed in 1887 and 1888 to illustrate this paper, are now preserved in the Provincial Museum at Halifax.

1888. Brown (George Stayley).—Yarmouth, N. S. Boston, 1888.—Chapter 7 (pp. 86-101) treats of the Micmacs.

1889. Patterson (Rev. George, D. D.).—The Stone Age in Nova Scotia, as illustrated by a collection of relics presented to Dalhousie College. Trans. N. S. Inst. Nat. Sc., vii, pp. 231-252. Read 11 Feb., 1889.

1889. Piers (Harry).—Aboriginal Remains of Nova Scotia, illustrated by the Provincial Museum Collections. Trans. N. S. Inst. Nat. Sc., vii, pp. 276-290, with 1 plate illustrating 6 specimens. Read 13 May, 1889.

1890. Rand (Rev. Silas Tertius).—Legends of the Micmac Indians. American Antiquarian, vol. xii, p. 3; Chicago, 1890.

1891. Pilling (James Constantine).—Bibliography of the Algonquian Languages. Washington, Bureau of Ethnology, 1891. 614 pp.— An exhaustive work on the subject, giving full titles and biographical sketches of authors of works dealing with the language of the Micmacs, etc.

1893. Mallary (Col. Garrick).—Picture-writing of the American Indians. In 10th Annual Report of Bureau of Ethnology, 1888-9; Washington, 1893—Describes petroglyphs on Fairy rocks, Queens Co., N. S., on pp. 37-42, and figures Nos. 1, 2, 549, 550, 654 to 658, 717, 718, 739 to 741, 1254, 1255, and 1262, illustrate Nova Scotian examples.

1894. Rand (Rev. Silas Tertius, D. D., D.C.L., LL. D.).—Legends of the Micmacs. New York & Lond., 1894. xlvi, 452 pp.—Pp. xvii-xxix give bibliography of Rand's works and biblical translations in Micmac; and on pp. xxx-xlvi is an account of the manners, customs, language, and literature of the Micmacs from Rand's pamphlet, "A Short Statement of Facts" (1850).

1895. **Piers (Harry).**—Relics of the Stone Age in Nova Scotia. Trans. N. S. Inst. Nat. Sc., ix, pp. 26-58, with 3 plates illustrating 98 specimens, nearly all in the Fairbanks collection. Read 13 May, 1895.

1895. **DesBrisay (Judge Mather Byles).**—History of the County of Lunenburg. 2nd ed. Toronto, 1895.—Chapter xxx (pp. 341-351) is devoted to the aborigines, murders and scalpings by them, burial places, and interesting incidents.

1896. **Hagar (Stansbury).**—Magic and Medicine of the Micmacs. Journal of Am. Folk-Lore, vol. ix, p. 170; Boston, 1896.

1897. **Hagar (Stansbury).**—Weather and the Seasons in Micmac Mythology. Journal of Am. Folk-Lore, vol. x, p. 101; Boston, 1897.

1897. **Calnek (W[illiam] A.)** and **Savary (Judge A W.).**—History of County of Annapolis. Toronto, 1897.—Contains a few references to the Micmacs.

1899. **McLeod (Robert R[andall]).**—In the Acadian Land: Nature Studies. Boston, 1899.— The Micmac Indians are described on pp. 140-155.

1900. **Gatschet (A[lbert] S[amuel]).**—Micmac Fans and Games. Bulletin of Free Museum of Science and Arts, Department of Archæology and Palæontology, Univ. of Penn., vol. ii, No. 3, May, 1900, pp. 1-5.— Describes fans, and the game "altesta-an."

1900. **Wilson (Isaiah W.)**—Geography and History of the County of Digby, N. S. Halifax, 1900.— Pp. 21-26 treats briefly of the Micmacs.

1903. **McLeod (Robert R[andall]).**—Markland or Nova Scotia. [Chicago?], 1903.—Chapter xi, pp. 166-175 is on the Indians of Nova Scotia.

1907. **Hodge (Frederick Webb).**—Handbook of American Indians. 2 vols. Bulletin Bur. of Am. Eth., 30. Wash., 1907. Article 'Micmac,' vol. 1, pp. 858-859 (by Jas. Mooney & Cyrus Thomas).

1908. **Hewitt (Harry W.).**—Customs of the Micmac Indians. Unpublished manuscript of 33 pp., read before N. S. Historical Society, 21 April, 1908, and preserved in files of that Society.

1910. **Eaton** (Rev. Arthur Wentworth Hamilton, D. C. L.).—History of King's County, N. S. Salem, Mass., 1910.— Chapter 2, pp. 10-22, treats of the Micmacs.

1910. **Piers** (Harry).—[Anthropological Accessions to Provincial Museum.] Report on Prov. Museum for 1910, in Report of Department of Mines of N. S., for 1910, pp. 205-210.—Describes Creed's copies of petroglyphs on Fairy rocks, etc., recent costumes, work and implements of Micmacs. Earlier reports contain short items on similar subjects.

1911. **Prest** (Walter H.).—Suggestion for Anthropological Work in Nova Scotia. Read before N. S. Inst. Sc., 13 Feb. 1911, and to be published in its Trans., vol. xiii, pp. 35-39.

1911. **Prest** (Walter Henry).—Report on Cave Examination in Hants Co., N. S. Trans. N. S. Inst. Sc., vol. xiii, pp. 87-94.—Negative results from a search for prehistoric remains in three caves selected for investigation.

1911. **Piers** (Harry).—[Anthropological Accessions to Provincial Museum.] Report on Provincial Museum, for 1911, in Report of Department of Mines of N. S., for 1911, pp. 239-241.—Describes some implements and natural forms of rock which have been mistaken for the work of Indians, &c.

The student is also referred to the following volumes of manuscript documents (among others) preserved in the Public Records of Nova Scotia:—

Vols. 430-431. Papers relating to Indians in Nova Scotia, from 1751 to 1866.

Vol. 432. Journal kept by Hon. Joseph Howe while Commissioner of Indian Affairs (appointed 1842), containing also plans of Indian reserved lands.

The Electrical Resistance and Temperature Coefficient of Ice.—By J. H. L. Johnstone, B. Sc., Dalhousie University, Halifax, N. S.*

Read 13th May, 1912.

The following investigation was first begun in January, 1911, with the object of determining the resistence of ice.

A great many difficulties were subsequently met with, which resulted, as will be seen, in a modification of the original methods of experiment; and several other problems appeared, closely connected with the one treated of in this paper, the chief one of which is the effect of polarization, and its nature as related to ice. The latter problem is to be investigated fully at a later time.

Dr. H. L. Bronson, when working in the Physical laboratory at McGill University, noticed the peculiarities connected with this problem and as a result this work was undertaken, with his guidance, by the writer.

The only measurements of the resistance of ice, that could be found after a diligent search, were obtained from a paper by Ayrton and Perry.[1] As these measurements appear to be the only ones published, a brief summary, together with the results of their work, is given here.

Aryton and Perry measured the resistance of ice as follows:

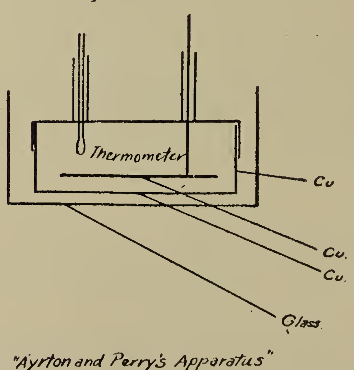


Fig. 1.

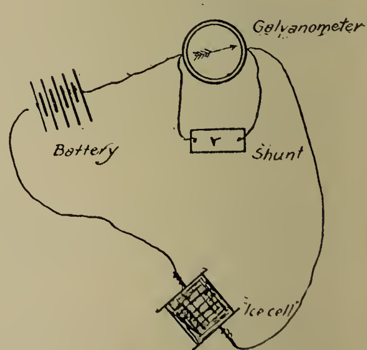


Fig. 2.

* Contributions from the Science Laboratories of Dalhousie University—[Physics].

[1] Ayrton, M. E., and Perry: Proc. London Phys. Soc., Vol. II, 178, March, 1877.

Ice was frozen from distilled water in a copper vessel, like that shown in Fig. 1. Connections were then made as shown in Fig. 2, the current passing through the ice being measured by a galvanometer. Knowing the E. M. F. of the cells in the

TABLE I.

AYRTON AND PERRY'S
VALUES
FOR THE RESISTIVITY OF ICE AND H_2O.

TEMPERATURE °C.	RESISTIVITY.
-12.4	22.4×10^8
-6.2	10.23×10^8
-5.02	9.486×10^8
-3.5	6.42×10^8
-3.0	5.693×10^8
-2.46	4.844×10^8
-1.50	3.876×10^8
-0.2	2.84×10^8
$+0.75$	1.188×10^8
$+2.2$	2.48×10^7
$+4.0$	9.10×10^6
$+7.75$	5.4×10^5
$+11.02$	3.4×10^5

Resistance in ohms. ("BA").

TABLE II.

SPECIMEN.
AYRTON AND PERRY'S
RESULTS.

VOLTAGE	TIME	GAL. DEFLECTION
2.61	0	30.1
4.25	1	39.5
	3	36.5
	4½	50.5
8.7	5½	49.1
17 4	6½	72.7
	7½	69.0
	12½	59.5
28.7	13½	76.5
	17½	67.2
Ice short	circuited for 4	minutes
87.	—— great swing	off scale.
	23½	212
	26½	145
	83	66.2
	129	66.2

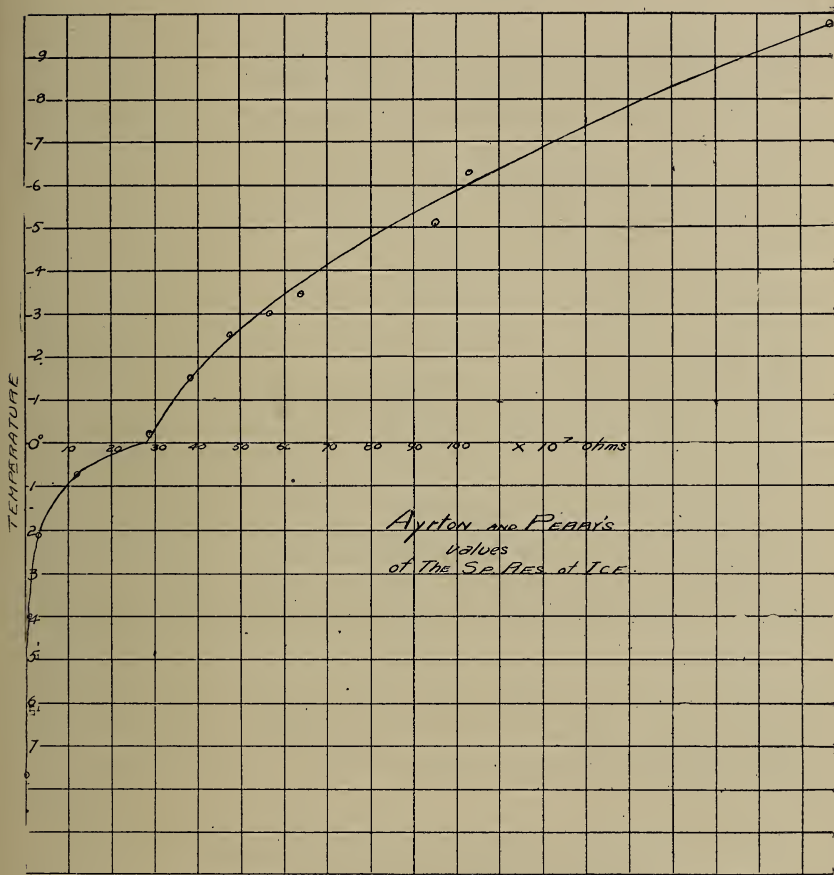


FIG. 3.

circuit, the resistance of the sample of ice was calculated from these data, and from this, the specific resistance of the ice. This was done for several temperatures.

A great difficulty was encountered in determining the actual value of the current passing through the ice. Ayrton and Perry were troubled greatly by polarization effects which, at that time, they were unable to determine the nature of. As they could not eliminate this effect, which will be shown to be

very considerable at times with the method of experimenting, their results do not appear to be very reliable.

The method just outlined was first used and investigated, with results similar to those obtained by Ayrton and Perry[1] and to those obtained by Dr. Bronson.[2]

A D'Arsonval galvanometer, manufactured by Leeds and Northrup, was used as a current measurer, its sensitivity and resistance being first determined.

The resistance was determined by several methods, the mean of these several values being taken and found equal to 1930 ohms, at 17°C.

The sensitivity, or current which produces a deflection of one scale division was determined as follows:

The galvanometer was connected in a circuit as shown in Fig. 4.

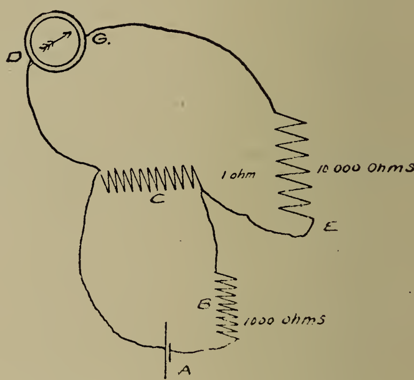


FIG. 4.

E is a 10,000 ohm resistance coil,
C is a standard one, (1), ohm coil,
A is a storage cell,
B is a 1000 ohm coil.

The E. M. F. of the storage cell, as determined by a Weston voltmeter was 2.00 volts, so the current passing through the galvanometer, $i = \dfrac{\frac{2}{1000}}{10000 + 1930}$ amperes.

1. Loc. cit.
2. Loc. cit.

It was observed that this current produced a deflection of 51 scale divisions. Therefore the current necessary to produce a deflection of one scale division, will be

$$\frac{\frac{2}{1000}}{(10001+1930)\,51} = 3.29 \times 10^{-9} \text{ amp.}$$

The specimen of ice was prepared as follows: Two brass electrodes,—circular discs, were made; a copper rod was soldered to one of them and a copper wire was soldered to the edge of the other one. A cylinder of ice, 3 cm. in height, was cut from ice, obtained from the Dartmouth Lakes. The electrodes were then frozen to this cylinder of ice by warming them slightly and then pressing them to the upper and lower surfaces of the ice. This conductivity cell, so to speak, was placed on a plate of parafine wax, and the whole thing was placed in a box, which was kept in the open air, shaded from the sun. Of course experiments could only be performed when the air was below the temperature of 0°C, which was quite frequent at this period of the year. Several sets of readings are given below, together with a set of readings from Ayrton and Perry's papers.[1] The apparatus was connected up as in Fig. 2.

In the actual experiment, the current was made to pass through the ice for a considerable period of time, in some cases the circuit being unbroken for 48 hours.

When the current was suddenly reversed after flowing for quite a length of time in one direction, a very much greater deflection of the galvanometer was obtained than at first. This deflection decreased somewhat with time. Thus for instance, the deflection changes from 9 divisions, on one side of the zero, to 13 divisions on the other side when the current is reversed through the ice. This is an increase of 40% of the current, which passed through the ice in the initial case. If this is all due to

[1]. Loc. cit.

TABLE III.

JAN. 24, 25, 26, 1911.

Time	Temp.	Shunt	Voltage	Deflection Right	Deflection Left
Jan. 24— 4.15		1 ohm.	20.9	9	13
4.45		"	"	6	15
4.50		"	40.7		27.5
8.0		"	20.9		3.5
10.00		40	1 "	102.0	106.0
" 25—10.45	−.5°C	30	"	140*-65	
" " 12.00	"	"	"	73-23 †	83-37
" " 12.35	"	"	"	80.-29	
1.00	"	"	"	16	
2.00	+ 1°	"	"	175-158	
" 26—10.25	− 6°	"	"	17-15	19-15
10.30	"	"	20.1 cells	25	
10.45	"	"	40.7	102-23	
12.50	− 5°	"	10 cells	15-16½	

* The current took 10 seconds to fall from "140-65" in value.
† The current took 3 seconds to fall from 73–23 in value.
In the 2nd column we have the temp. of air beside the ice, recorded.
In the last column the deflections of the gal., and the deflections when the current is reversed, are given.

polarization, the phenomena we have here to treat of, are quite different from the so-called electrolytic polarization effects. Ayrton and Perry[1] noticed similar effects on reversal, and on short-circuting their "cell," (see page 128). In one case, it will be seen that on short-circuiting their cell, the current increased about 175% of its original value. Similar results were consistently obtained by the writer.

1. Loc. cit.

As resistances calculated from such values of the current as the above would have little or no value, a method was then sought, whereby the effects just indicated could be eliminated.

A great deal of time was spent in attempting to find out the nature of this polarization and measure its value. The "Tuning Fork"[1] method of measuring electrolytic polarization was used first of all, with water as the electrolyte, and correct values were obtained. But when the ice cell was substituted for the water cell, this method would give no results on account, principally, of capacity effects. A "commutator" method was also tried with similar results.

By using Kohlrausch's method for measuring the resistance of electrolytes, the polarization effect would probably be eliminated. However, the maximum resistance that can be measured by this method is of the order of 10^6 ohms. As ice has a specific resistance of more than 10^8 ohms, this method is not practicable. It might be possible however, by taking thin sections of a block of ice, to measure its resistance by means of Nernst's conductivity apparatus.[2]

Now one of the methods of measuring the resistance of a solid conductor, is to determine the drop in potential between two sections of the substance, when a steady current is flowing through these sections. Knowing the values of i and e, the resistance can be calculated.

A method very similar to the above was adopted, and as will be shown, the effects of polarization, etc., will be eliminated as far as the measurement of the resistance is concerned.

The apparatus was set up, as shown in Fig. 5. B, is a "U" tube, 12 cm. in height, with a bore of about 2 cm. a and a_1 are glass tubes of $2\frac{1}{2}$ mm. bore, with platinum points sealed at the ends c and c_1. b and b_1 are glass tubes of 4 or 5 mm. bore, with

---

1 Watson, M. :—Text book of Physics, page 790.

2 Nernst, W. :—Zeitschr. f. phys. Chem., **14**, 622, (1894); also Maltby, M. E. : *ibid.* **18**, 133, (1895).

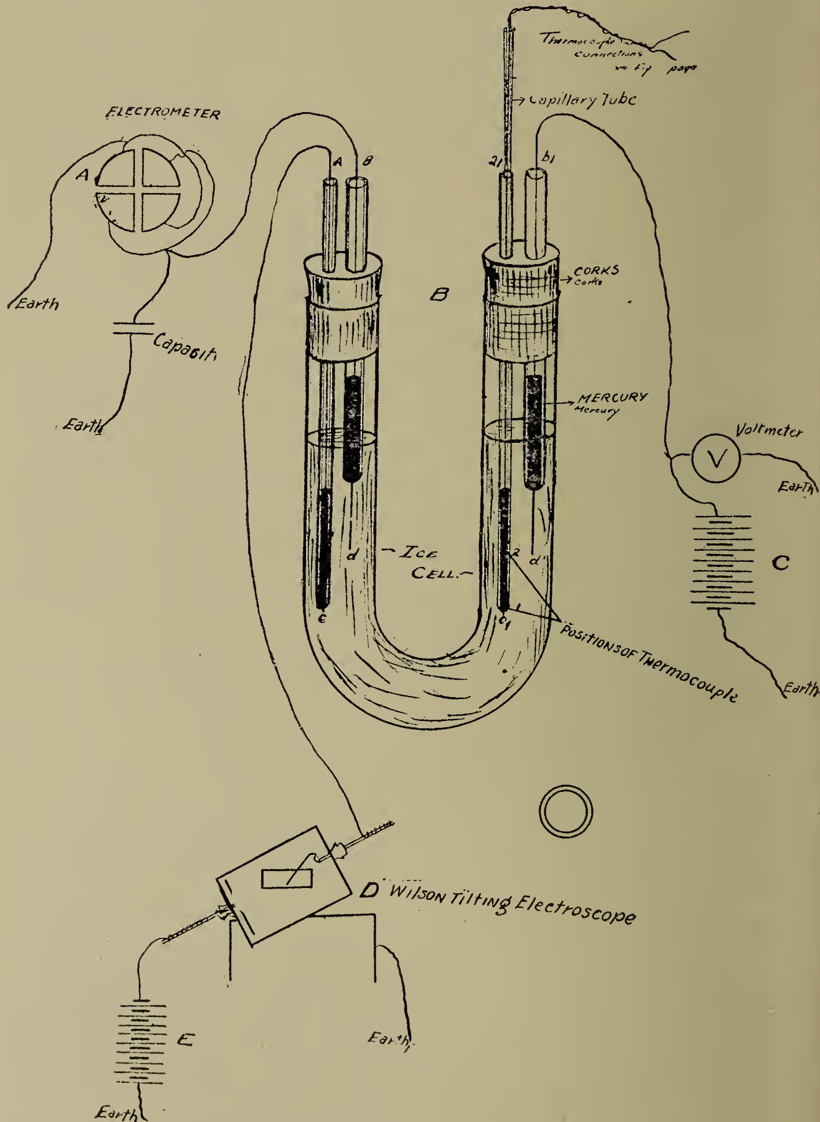

ELECTROMETER
A
Earth
Capacity
Earth
A
B
a1
b1
Capillary Tube
B
CORKS
MERCURY
Voltmeter
V
Earth
d
Ice
Cell.
d'
C
Positions of Thermocouple
Earth
D Wilson Tilting Electroscope
E
Earth
Earth

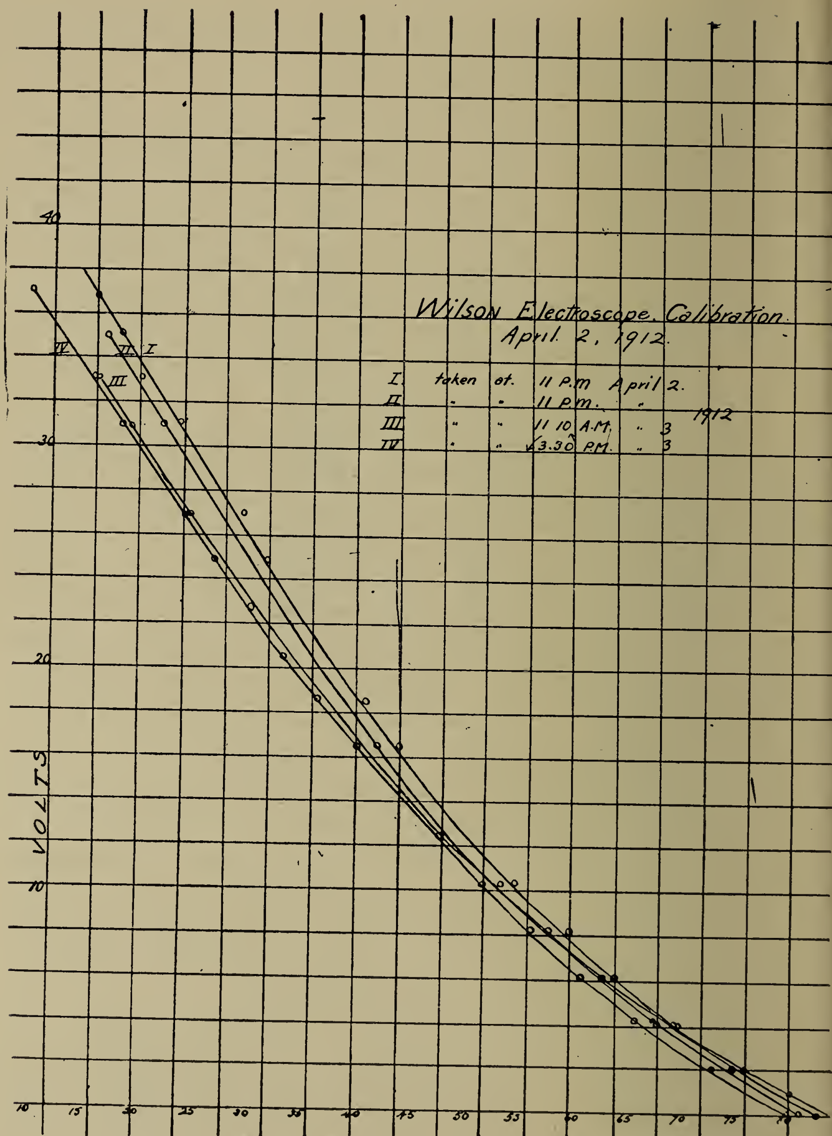
FIG. 5.

platinum wires, d and d_1 sealed in the end as shown in the figure. These four tubes are fitted carefully in corks, and then in the "U" tube as shown.

Now suppose we fill the tube with an electrolyte and pass a current through it, by way of the electrodes b and b_1. There will result a polarization at these electrodes and the value of the current will vary somewhat with the time. If this current is measured by a sensitive galvanometer and if the difference in potential of the two electrodes is measured by a voltmeter, a value of the resistance of the electrolyte could be calculated at any particular time; but this is a varying quantity, and not the true resistance of the electrolyte.

Now if two other electrodes a and a (see Fig. 5), are placed in the position shown in the figure, their ends c and c_1 being lower somewhat than the extremities of the platinum wires d and d_1, and then a current is passed through the electrolyte by way of the electrodes d and d_1: then if we measured the difference of potential between the points c and c_1, by some electrostatic instrument and knew the value of current, we could calculate the value of the resistance of the electrolyte between the points c and c_1, and the resistance so calculated would be constant in value and unaffected by polarization. This would be so, because when there is a variation in the current due to polarization or any other causes, there will be a proportional change in the potential difference between the two potential electrodes, so that the ratio of the potential difference to the current will be constant (with a const. temp.). Therefore the resistance determined in this way will have a constant value. Thus, polarization effects will be eliminated.

The current passing through the electrolyte, (which was ice in this case), was measured by a *Dolezalek* electrometer, A, (see Fig. 5). The potential of each potential electrode was measured by a *Wilson Tilting* electroscope, D, the plate of the electroscope being kept at a potential of 320 volts, from small storage cells. A calibration curve for this instrument, as it was used in these experiments is shown in Fig. 6. It



Wilson Electroscope. Calibration.
April. 2, 1912.
I. taken at. 11 P.m April 2.
II " " 11 P.m. "
III " " 11 10 A.M. " 3
IV " " 3.30 P.M. " 3
1912
VOLTS
40
30
20
10
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80

FIG 6

will be seen that this method of measuring high resistances of any kind, insulators for example, is very advantageous, for currents as small as 10^{-14} amperes, can be measured with ease by the *Dolezalek* electrometer, while the *Wilton Tilting* electroscope can be made very sensitive. For electrolytes with low resistances, the current could be measured by a galvanometer and the potential by the electrometer, since the latter as a current measure would be too sensitive for use in this case.

Preparation of the Ice.

Pure water was obtained with a resistivity of about 1×10^6 ohms.

After cleaning the "U" tube very carefully—first, in a solution of potassium bichromate and sulphuric acid, then in an alcohol-ether solution and then washing several times in distilled water, both hot and cold—the pure water was put in the tube, its resistance carefully determined and temperature noted. The specific resistance of a sample of this water was then determined by the *Kohlrausch* method, the temperatures being the same in the two cases. From these results the "cell constant" of the apparatus can be calculated.

The "U" tube was then placed inside a cylindrical glass vessel, about 15 cm. in diameter and 45 cm. in height. This was then placed in an earthenware-jar, which in turn was surrounded by an ice-salt mixture, contained in a bucket. The while apparatus was kept in a refrigerator.

A thermo-couple (Fig 7) consisting of a German-silver-iron junction, was used to measure the temperature of the ice, which was formed in the "U" tube. The junction was enclosed in a capillary tube, which could be slipped in and out of one of the electrode tubes, "a ", (Fig. 5). For a diagram of the connections of the thermo-couple see Fig. 7. A very careful calibration of this instrument was made over the range of

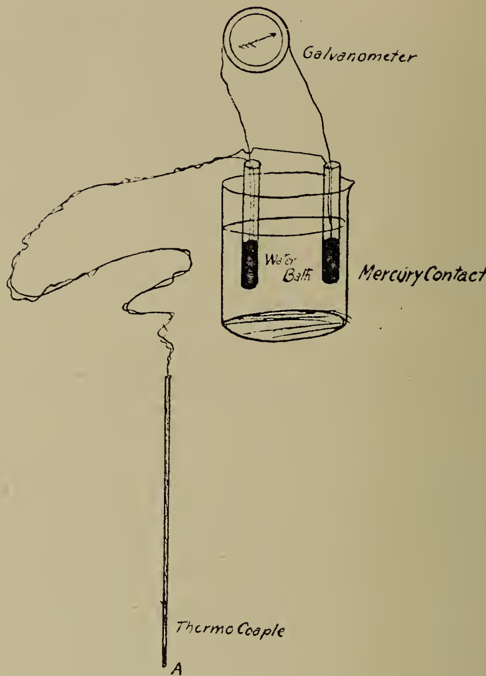


FIG. 7.

temperatures through which it was to be used in the experiment, viz.—from 5° to —12°C.

It was found very difficult to freeze the water in the "U" tube in the method described, without the tube being broken by the expansion of the ice. To obviate this difficulty a piece of rubber tubing, about .5 cm. in diameter and 15 cm. in length, and very carefully cleaned by boiling, etc., was closed at one end, by means of a glass stopper. The other end was also closed with the exception of a small hole, the size of a pin-head. This tubing was placed inside the "U" tube, care being taken to prevent any quantity of water entering through the opening in the one end. When the water expands on freezing, it can be seen that a certain amount of freedom is allowed it, by its being able to push in the lateral surface of the rubber

tubing, the air inside escaping through the pin-hole. It was found that the water could be frozen with ease in this way without the glass tube being broken.

The electrometer was then calibrated. In this experiment, the needle was changed to a potential of about 200 volts. The electroscope was then calibrated over the range at which it was to be used.[1]

To obtain a set of readings at different temperatures, the "U" tube was connected up with the electrometer and electroscope and source of current, (Fig. 5). In most of the experiments the current was obtained from 10 storage cells, which gave an E. M. F. of about 20 volts. The "U" tube was very carefully packed in the glass vessel with "felt" and so temperature changes were slow. The time, in seconds, for the electrometer needle to pass over 100 scale divisions, was recorded on a stop-watch. The temperature of the ice was then read from the thermo-couple. The potential difference of the two electrodes, c and c_1 (Fig. 5), was then determined from the electroscope readings at these points.

If $d \equiv$ the scale divisions passed over per second by the electrometer needle;

$D \equiv$ the number of divisions per volt, and $C \equiv$ the capacity of the system in microfarads, then the current, i, passing through the ice will be,

$$\frac{C\,d}{10^6\;D} \text{ amperes.}$$

If $V \equiv$ the potential difference of the two electrodes c and c_1, then R, the resistance of the electrolyte between c and c_1 will be,

$$\frac{V \times 10^6 \times D}{C\,d} \text{ ohms.}$$

If k denote the cell constant of the apparatus then the specific resistance of the ice will be,

$$\frac{V \times 10^6 \times D \times k}{C\,d} \text{ ohms.}$$

1. See Fig. 6.

In the following table column I gives the time at which the readings were taken; column II the readings of the electroscope, when the gold leaf was connected with each one of the potential electrodes, c and c_1; column III, the time taken for the electrometer needle to pass over 100 scale divisions; column IV, the temperature of the water bath in Fig. 7, the reading of the galanometer, and the calculated temperature of the ice; column V, the electromotive force used in the experiment; column VI, the capacity of the system; column VII, the calculated resistance and column VIII, the specific resistance of the ice. In the experiments performed, readings were taken as the temperature of the ice decreased to the minimum temperature for the particular salt and ice mixture in the outer vessel, and then as the temperature rose up to zero.

TABLE IV.

Resistance of Ice

Cell. Constant = .315 April 2, 1912

Time	Electroscope		Electrometer	Temperature				E. M. F.	Cap.	Specific Res. (Ohms.)
	I.	II.		I. Th Cp	II. Th. Cp	Cal.	Temp			
4.10	15-83	61.1-83	1m. 24 s.	126	125	16.9	19.3°	41.2	0.05	3 86x10^9
4 30	"	"	1m. 25 s.	127.8	125.5	17.0	19.7	"	"	3.90x10^9
4.40	"	"	1m. 28 s.	128	125.5	16.9	19.9	"	"	4.04x10^9
5.55	"	64.5-83	1m. 30 s	127	122	16.9	19.6	"	"	4.13x10^9
7 40	14 5-80	62.0-80	1m. 17 s.	121½	"	16.3	18.6	"	"	3.56x10^9
8 00	82-15	62 5-82	1m. 13 s.	120.2	118.8	16.4		"	"	3.47x10^9
9.00	15-81.5	59.0-81	1m. 0 s.	117.0	117.0	16.4	17.2	"	"	2.69x10^9
10 00	16-81 3	58-81-5	45 s	112.6	112.0	"	15 9	"	"	1.98x10^9
10.04	81 5-16	"	46 "	111.1	111.0	"		"	"	
10 15	"	"	44 "	112.1	111.6	"	15.8	"	"	1.94x10^9
10.20	81.3-16.5	58-81.3	45 "	111.0		16.4		"	"	
10.40	"	"	40 "	109.5	110.0	"		"	"	
11.00	14.5-81	55.5-81	22 "	95.0	93	"	10.8	"	"	
"	"	"	89 "	"	"	"	"	"	0.2	0 947x10^9
11.10	"	"	90 "	94.5	"	"	10 6	"	"	0.958x10^9
11.17	15 81.5	55-81.5	88 "	93.0	91.5	16.3	10.3	"	"	0.936x10^9
11.40	"	"	88 "	90		"	9.4	"	"	0.852x10^9
12.00	16-81.5	53.8-81.5	41½"	75	73.5	16.8	4.5	"	"	0.457x10^9
12.15	"	"	39 "	72.5	72.0	16.75	3.85	"	"	0.430x10^9
12.25	15-81.5	54.2-81.5	38½"	71.5	70.0	16.8	3.5	"	"	0.410x10^9
A. 3.										
10.15	23-80 5	67 80.5	48 "	77.3	76.0	14.8	7.1	"	"	0.464x10^9
10 25	"	"	" "	77.1	76.0	"		"	"	
11.10	20-82.5	64-82 5	79 "	62.1	61.0	15.2	2.3	"	1.00	0.169x10^9
11.15	"	66-82.5	85 "	63.0	61.3	15.2	2.6	"	"	0.181x10^9
11.33	"	"	36 "	77.5	77.0	15.3	6.8	"	0.20	0.390x10^9
11.37	"	"	39 "	81.0	79.1	"	7.8	"	"	0.423x10^9
11.47	21.6-82.6	62-82.6	21 "	56.8	55.6	15.4	0.6	"	1.00	0 0386x10^9
11.55	"	"	19½"	55.0		"	0.1	"	"	0.0349x10^9
12.00	"	"	19 "	"		"		"	"	
12.10	20.0-82.4	58-82.4	21 "	55.1	57.0	"	0°	"	"	0.0367x10^9

It was found that the rubber tubing in the "U" tube affected the conductivity of the contents to quite an extent, and in this particular experiment the water was frozen without the presence of the rubber, and also in the suceeding experiments. However, the general shape of the temperature resistance curve was found to be the same in every experiment performed.

The water, which was put in the cell originally, had a specific resistance of about 1.4×10^6 ohms at 17.9°C.

In the measurement of the temperature of the ice between the "potential" terminals, by the thermo-couple, it was found that there was a considerable temperature-gradient in the "U"

tube in the direction of its length, although the tube was enclosed in three separate vessels, in a refrigerator and closely packed with felt. The junction of the thermo-couple was enclosed in a capillary-tube, (see Fig. 7), so that it could be placed inside the "potential-terminal-tube," c_1 (see Fig. 5). A reading of the galvanometer was taken when the end of the capillary tube reached the end of the "potential-terminal-tube." The capillary tube was then drawn up about 3 centimeters or so and another galvanometer reading was made. The average of these two readings was taken as the average temperature of the ice between the potential terminals.

When the water was frozen, cracks were observed through the ice in the "U" tube, and it was found impossible to obtain ice at low temperatures, by freezing in the tube, without the cracks

These cracks may have a considerable effect on the resistance of the ice. So the accuracy of the values of the specific resistance as given in this paper, is limited by this uncertainty.

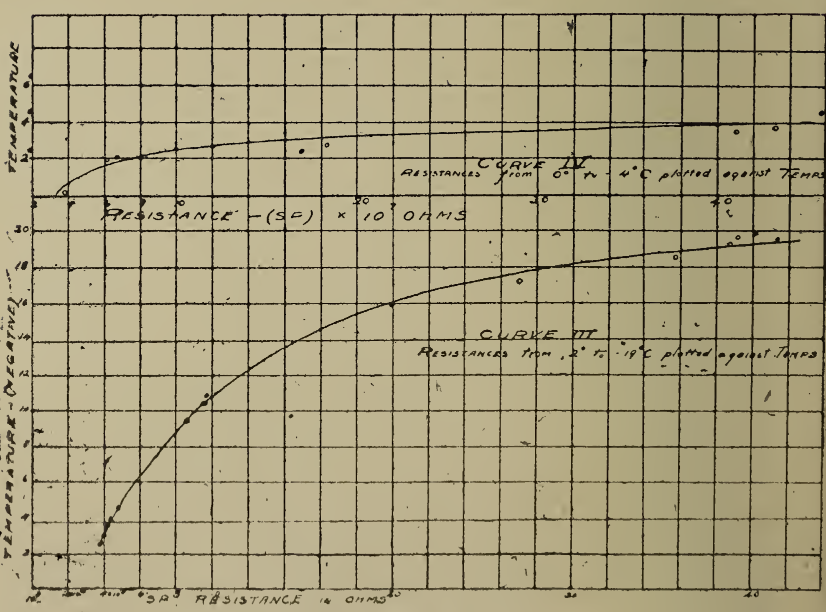


Fig. 8.

A temperature-resistance curve is shown in Fig. 8, and it will be observed that it is nearly *expotential.* This was found to be the case in every curve of six, plotted.

The specific resistance of the ice was found by multiplying the resistance of the ice between the "potential-terminals" by the "cell-constant"[1] of the tube.

To determine the temperature co-efficient of the resistance at different temperatures, the *cotangent* of the temperature-resistance curve, (Fig. 9), was determined graphically at different temperatures, and this was divided by the resistance of the ice at this point. Thus if R_t is the specific resistance at temperature t then the temperature co-efficient at this temperature will be $\frac{1}{R_t} \times \frac{d\,R_t}{d\,t}$. For the temperature co-efficient curve, see Fig. 9.

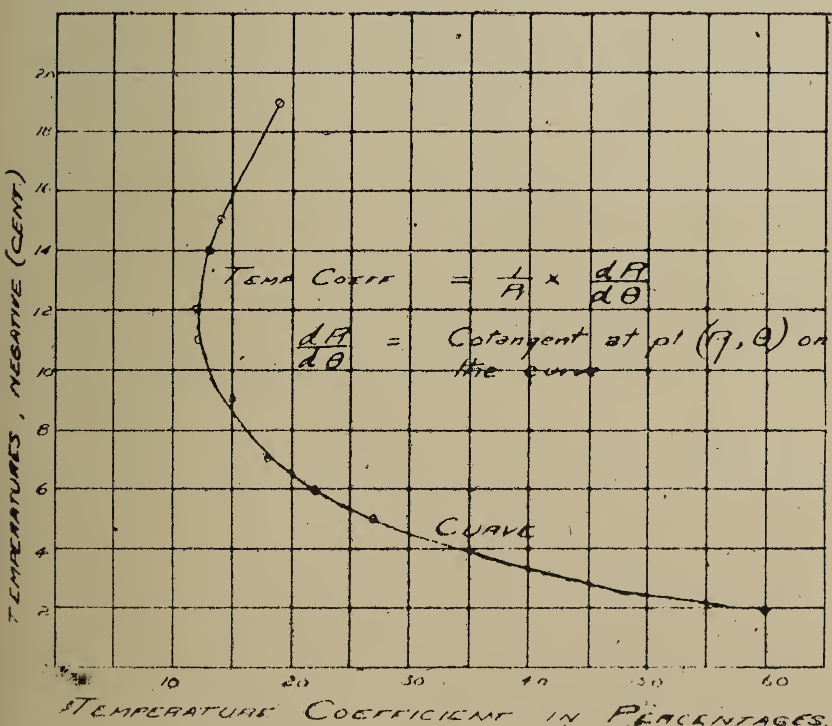


FIG 9.

1. Kohlrausch, F., Physico-Chem. Measurements.

SUMMARY.

1. The specific resistance of ice has been determined at temperatures ranging from 0° to — 19°C.

2. The effects of electrolytic-polarization have been eliminated by the method used.

3. *The value of the temperature-co-efficient of the resistance of ice has been determined at different temperatures and its value has been found to be very much higher than the temperature-co-efficient of ordinary electrolytes. It decreases in value as the temperature decreases from zero.*

The values obtained for the specific resistance of ice compare fairly well with those obtained by Ayrton and Perry, using a different method.

In conclusion I wish to thank Dr. H. L. Bronson, who suggested this work, and without whose kind supervision and assistance, this research could not have been undertaken.

Dalhousie University, Halifax, N. S.
April 20th, 1912.

The Geological Age of Prince Edward Island.—By Lawrence W. Watson, M. A., Charlottetown, P. E. I.

Read 8th April, 1912.

The exact position of Prince Edward Island in geological time has long been a matter of uncertainty. That it was limited in one direction by the Upper Carboniferous and in the other by the Trias, was recognized by all the Canadian geologists who have examined the rocks of the island, notably Gesner, Sir William Dawson, Dr. Ells of the Geological Survey of Canada, and the native naturalist, Francis Bain; but the general similarity of the rocky constituents, the conformability of the strata and the scarcity of fossils rendered the recognition of possible plurality of formations difficult, if at all possible.

The lowest beds, with outcrop on St. Peter's and Governor's Islands in Hillsborough Bay, and on the still more easterly extension of the same anticline at Gallows or Gallas Point, were early recognized as similar in character and geological horizon with the Upper Carboniferous beds of the northern coast of Nova Scotia, and of parts of New Brunswick opposite to Prince Edward Island.

Along the western shore of Prince Edward Island, from Cape Wolfe to Nail Pond, the lowest strata disclose rocks of an almost equally ancient origin as those of the Hillsborough Bay anticline above mentioned.

In some places on the mainland, as about Cape Tormentine, these lowest beds of dark red or brown sandstones with conglomerates and grey streaks (indicating the elimination of colouring matter by vegetable organisms), with plant fossils characteristic of the Upper Carboniferous formation, pass, without stratigraphical demarcation into the red sandstones, impure limestones, and shales which form the bulk of the rocks of Prince Edward Island.

Because of the want of distinct demarcation between the Upper Carboniferous and the next succeeding Lower Permian systems, Sir William Dawson assigned the lowest and middle rocks to his "Permo-Carboniferous" system, but, from the finding at New London of the fossil jaw of an animal, named by Dr. Leidy *Bathygnathus borealis*, which he (as now transpires, erroneously), concluded was a triassic dinosaur—a conclusion accepted by the great palæontologist Cope—Sir William Dawson assigned the district in which the fossil was found to the Trias, the age next succeeding to the Permian.

Sir William Dawson's latest expressed opinions as to the red sandstones of Prince Edward Island are contained in his *Handbook of Canadian Geology* (1889), pages 97 to 101, from which the following summary is compiled:

The Permian System. The Permo-Carboniferous red sandstones of Prince Edward Island and eastern Nova Scotia are typical of the Lower Permian. Their fossils are for the most part generically similar to those of the Carboniferous. The Upper Permian is not represented in Canada. The Permian, or Permo-Carboniferous of Prince Edward Island does not yet admit of any division into distinct groups and it rests conformably on the upper coal formation without any stratigraphical break. It is characterized by a prevalence of sandstones and shales coloured by the red oride of iron.

The Triassic System. The Bunter sandstone (the lowest of the three divisions which gave its name—Trias—to the system) is represented in Canada by the lower new red sandstone of the Bay of Fundy and Prince Edward Island, associated with trappean rocks. Its fossils are conifers and cycads, and the footprints of dinosaurs. The limestones of the Middle Trias of Germany and eastern France are not found in eastern America. To the Keuper sandstone (the uppermost of the triad series) belong the upper sandstones of Prince Edward Island and the Bay of Fundy, where its trappean beds form

the North Mountain of Cornwallis and Annapolis counties. In both Nova Scotia and New England the triassic age was remarkable for the deposition of red sandstone in shallow bays and straits, and for the ejection of great dykes of basaltic and amygdaloidal basic volcanic ash. In Prince Edward Island, "owing to the slight dips of the Permian and Triassic, and their mineral similarity, it has proved difficult to define their boundaries; but the Trias appears to rest in slight troughs of the Permian and to be partly composed of its rebris."

Thus Dawson's accrediting to Prince Edward Island, beds of Triassic origin was doubtless due to the opinion of Leidy (endorsed by Cope) that the fossil, *Bathygnathus borealis,* Leidy found at New London, was a dinosaur characteristic of the Trias. In a letter to Francis Bain, Sir William wrote as follows: "Look well to the north side of the island for the true Trias." Bain was such an enthusiastic believer in the existence of Triassic deposits in Prince Edward Island, that he contributed to the *Canadian Science Monthly,* in 1885, an article, entitled, "Bounding the Trias," in which he defines the supposed limits of the formation, using, as a strong claim, the surface configuration of the country. According to this writer, the surface of the Permian districts is "like the gentle swelling of the summer sea," while that of the Triassic is "like a sea torn by the wildest conflict of contending winds and currents." He further defines the different characters of the sandstones of the two systems: "The Triassic consists of thick-bedded sandstones, and where rests on similar beds of the Middle Permian, it is difficult to distinguish between the two. But where it rests upon the uppermost beds of shale and fissile sandstones, the distinction is quite marked, and especially in scenic effect. . . . The Triassic sandstones are distinguished from the Permian by having less dark carbonaceous markings in them. There are fewer shales and no calcareous conglomerates, although some of the sandstones are indurated with lime. There are few well preserved fossils in the system so far as we have yet discovered. My fieldbook

contains drawings of over thirty different varieties of plants, but so indifferently preserved that not more than three or four of them could with certainty be referred to their proper species. Yet the group is readily recognized as distinct from similar remains in the Permian strata below . . . . *But these* [Triassic plant fossils] *would not have been sufficient to characterize the system if they were not associated with an undoubted Mesozoic dinosaur, Bathygnathus borealis.*" (The italics are mine. L. W. W.)

In view of the considerations submitted by Bain, Dawson in 1885 (*Canadian Record of Science,* vol. i, no. 3) wrote thus: "The general result, as far as the subdivision of the beds is concerned, would seem to be that the lower series is distinctly Permo-Carboniferous, that its extent is considerably greater than we supposed in 1871, *that there is a well-characterized overlying Trias*" (italics, L .W. W.), and that the intermediate series, whether Permian or Lower Triassic, is of somewhat difficult local definition, but that its fossils, as far as they go, lean to the Permian side.

Dr. Ells, of the Canadian Geological Survey ,in his report of his observations made in 1902, writes as follows: "With the exception of this fossil (*Bathygnathus*) from the New London area, it may be said that all the available evidence points to the opinion that the red sandstones and shales, of which the island is largely composed, may all be assigned to the Carboniferous horizon, or as some geologists prefer to call them, Permian.

In this somewhat uncertain state rested the information as to the age of the latest rocks until 1905, when, in an article published in *Science* (new series, vol. xxii, no. 550, p. 52) E. C. Case, an eminent authority upon the fauna of the permian beds of North America, disputed the identity assigned to the New London fossil, and stated his conviction that the fossil *Bathygnathus* instead of being the *lower* jaw of a Triassic dinosaur was the *upper* jaw of one of the most specialized

of the Pelycosaurs, such as occur in the Texas region, probably a Demetrordon or Nausaurus, "characteristic of, and not surviving the permian age."

Simultaneously, and independently, Dr. Von Huehne published a paper (*N. Jahrb. f. M. G. u. P. Beilage*, band xx., p. 343) in which he arrived at the same conclusion as to the nature of the fossil and the age of the beds in which it was found. In his "Revision of The Pelycosauria," published by the Carnegie Institution of Washington (1907), Mr. Case restates his conviction that the animal was a dinosaur characteristic of the Trias, but one of the Pelycosauria, "a highly specialized, primitive side branch of the Rhyncocephalia, which seemingly became extinct at the end of the Permian age."

Thus, as the existence of Triassic deposits in the northern and central parts of Prince Edward Island depends, even according to the enthusiastic champion of the theory, Francis Bain, entirely upon the supposition that *Bathygnathus borealis*, Leidy, was a dinosaur, and, as the animal has been adjudged a pelycosaur of Permian time by indisputable authorities, the conclusion is inevitable that, in the present state of our knowledge, Triassic deposits cannot be said to occur in this region, and that the whole rock system of the island is referable to the Permo-Carboniferous age.

The Canada Grouse (Dendragapus canadensis) in Captivity; Its Food, Habits, etc.—By Watson L. Bishop, Dartmouth, N. S.

Read 13th May, 1912.

The habitat of the Canada Grouse, commonly called in Nova Scotia the "Spruce Partridge" is, northern North America east to the Rocky Mountains, from the northern portions of New England, New York, Michigan and Minnesota to the limit of trees reaching the western coast in Alaska.

In this province it is mostly found in the spruce forests and swamp regions far from the habitation of man. It is very seldom seen in the vicinity of fields and clearings, which are the favorite resort of the Ruffed Grouse (*Bonasa umbellus*).

A few years ago I kept quite a number of these birds in a large enclosure for several years and this gave me an excellent opportunity to study their food and habits, an occupation of which I was very fond. Since that time I have had many inquiries in regard to the food and care of these birds in captivity. I am, therefore, writing this with a view to assist any who may wish to experiment in the domestication of this interesting species.

My first bird, a male, was got about the middle of September. I put him in a small pen with a black duck (*Anas obscura*) also a male; but they did not get along well together. The grouse kept continually nagging the duck about the pen, so that I had to separate them until I had built a larger enclosure (about 30 feet square). There they got along on more friendly terms. Not long after, I obtained three females. The question to be solved then was, how to feed them, which I soon learned was rather a difficult matter; for two of them sickened and died within three weeks. When I

found they were ailing, I tried every means to restore them to health but without avail. I had them replaced by others, however, as soon as I could get them. This was not long as I had offered a liberal price. I then began to study what their food supply consisted of in their wild state. I therefore carefully examined the contents of the crops of those brought me to be mounted, and found that their food consisted of the foliage of the red and white spruce, some crops containing a few buds of hacmatack or larch (*Larix americana*), and sometimes a few blades of grass.

The tops of several young spruce trees seven or eight feet long were then cut and stood up in the pen. As soon as they were in place the birds flew up in them and commenced feeding, and it was interesting to see how eagerly and adroitly they would strip the spine-like leaves from the branches. In gathering these spines from the twigs the bird makes a stroke nearly parallel with the branch on which they grow, striking outward towards the end of the limb, gathering perhaps a half a dozen leaves at a time. Then by a twisting movement of the head, the spines are partly broken and partly bitten off, leaving a small portion still in place on the twig. These movements are as rapid as those of a domestic fowl picking up corn.

These tree tops served for roosting places as well as food, and were replaced whenever needed to keep them fresh and good. In selecting trees for this purpose, the young thrifty growing ones must be got, for the birds will not eat those which are old and slow growing as the foliage is tough and hard. By pinching off the spines with the fingers it is quite easy with a little practice to select those which are most acceptable to the birds. During the winter this food was supplemented by a little bread and grain, wheat and buckwheat. Oats and barley were not relished. As the spring advanced and the spruce buds began to swell, they were eagerly eaten by the birds, and even after the new shoots had grown to a length of two or three inches the whole new growth was eaten. The cones were

also fed upon while young and tender. I lost one fine bird by eating cones after they had become too hard and woody to be digested. This seemed to cause great distress and pain. The sick bird would sit for hours on the ground with his body quite upright, and keep continually moving his neck and body from side to side. I could not understand the cause of this strange conduct until later.

After a few days in this condition, during which time he would eat nothing, he died. On examination I found a hard spruce cone which had lodged in the narrow passage before reaching the gizzard. This explained the strange position and movements of the body during the illness. He was trying to force the obstruction along and thus ease the pain. Gangrene had set in where the cone lodged and ultimately resulted in death.

I do not think this accident would have happened in a wild state as there would be a greater supply to select from and the hard cones would not have to be eaten. At this season almost any kind of tender young grass would be eaten. Later when the common grasses became tough and hard, clover and dandelions would be eaten, and these were supplied by cutting up the sod on which they grew and placing it in the pen. Grasses supplied in this way would not dry up as cut grasses. They would keep fresh and green until all was used up. Other food such as green peas and wild berries, bunch berries, and winter green particularly, were relished best. At all times in the year it is necessary to keep a good supply of fresh spruce where they can have all they want. This being one of their most natural supplies, tends to keep them in good health.

One winter, in February, a man brought me two of these birds in a small basket, just large enough to contain their bodies, with a cloth tied over the top having two holes to allow their heads to stick out. They were brought in on a slow ox team a distance of 15 miles. The two birds having been confined to so small a space and covered with a cloth became so hot that one was dead when it arrived, and the other did not

look as though it would live more than a few minutes. Its head was lying over to one side with eyes closed, and it seemed to be dying. I took it from the basket and gave it some pulp of grapes which revived it. Its body having been in such a hot place, and with no water to drink, it was dying of heat and thirst. With good care it soon recovered and became smart, and that spring laid eight beautiful eggs which I presented to Mr. J. Parker of Philadelphia.

These birds became very tame, in fact as tame as any domestic fowls, and would run to meet me at the door when I went to feed them.

The coloring of the eggs is deposited entirely on the surface and can be easily washed off when the egg is first laid. So soft is this pigment and so easily marked that the eggs will sometimes show scratches on the large end, caused by coming in contact with the coarse parts of the nesting material when being laid. It also fades if exposed to the light, so that eggs which are nest-worn or have been exposed to light for any length of time, lose much of their beauty.

The color of a fresh laid egg is almost exactly like that of the outer case of new young buds of the red and white spruce on which they feed. I often noticed that when they were fed plentifully on this food, the eggs would be more highly colored.

The birds usually lay an egg each alternate day, but sometimes there would be two days between in which the supply of pigment seemed to have been collecting to be deposited on the next egg, which is of a much deeper color than that of the normal egg.

A Few Measurements on the Electrical Conductivity of Acetophenone Solutions of Certain Organic Bases and Acids.—By H. Jermain Maude Creighton, M. A., M. Sc., Dr. Sc., Lecturer on Physical Chemistry, Dalhousie University, Halifax, N. S.

Read May 13th, 1912.

In an investigation[1] recently carried out by the author, it was found that the degree in which the decomposition of bromcamphor-carboxylic acid, in acetophenone solution, was accelerated by various alkaloids and other organic bases, was in most cases parallel to their affinity constants. As these affinity constants are for water solutions, it seemed desirable to determine whether the same order held when the conductivity of the bases was measured in acetophenone solution. Accordingly the following measurements were made.

Measurements on the conductivity of a number of substances in acetophenone have been made by *Dutoit* and *Friderich*[2], by the ordinary method of Kohlrausch. With the substances under investigation, however, it was found that this method was not sufficiently accurate, on account of the self-induction and electrostatic capacity effects that arose with the large resistances it was found necessary to employ.

The method employed, therefore, was the condenser method used by Nernst[3] and Miss Maltby[4]. By this method the resistance of the electrolyte is determined through substitution in one arm of a Wheatstone bridge arrangement, which consists of four electrolytic resistances. Here the disturbance arising from electrostatic influences is eliminated by means of two condensers of variable capacity. The procedure is the same as in the determination of the dielectric constant, wherein the galvanic conductivity is compensated.

1. Creighton, H. J. M.: Dissertation, Zürich, 1911.
2. Dutoit, P. and Friderich L.: Bull. Soc. Chim., **19**, 321, (1898).
3. Nernst, W.: Zeitschr. f. phys. Chem., **14**, 622, (1894).
4. Maltby, M. E.: *ibid.*, **18**, 133, (1895).

The apparatus used consisted of the following:

1. An induction coil and accumulator.
2. Liquid resistances (electrolytic).
3. Two variable condensers.
4. An electrolytic cell for the liquid being investigated.
5. A telephone.

The glass vessel used to hold the electrolytic resistances was of the form shown in figure 1. The arms AB and CD are about 10cm. long, the internal diameter of the former being 5mm. and of the latter 0.8mm. The platinum electrodes which fit inside these arms may be raised or lowered by turning. Both

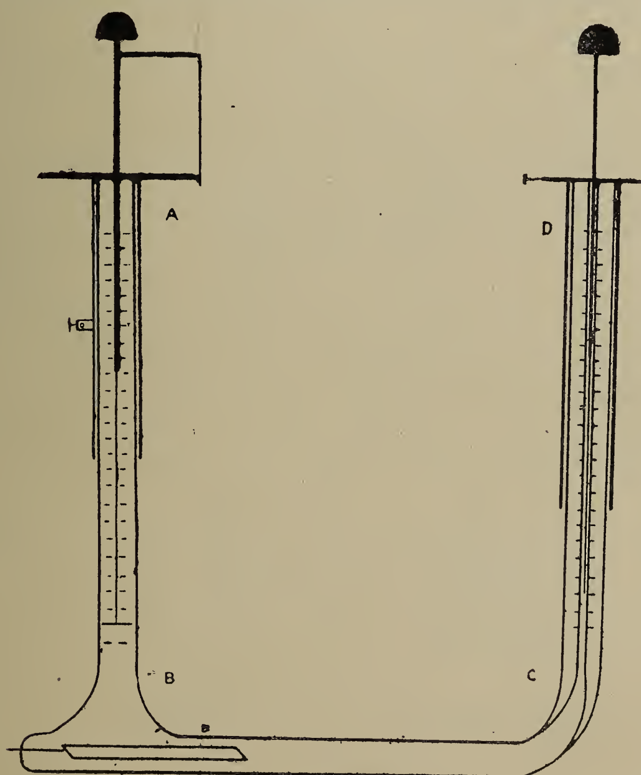


FIG. 1.

arms of the tube, as well as the metal disc at the top of AB, are graduated; AB in half millimeters and CD in millimeters. One complete turn of the larger electrode raises it 0.45mm., and since the metal disc at the top is divided into 100 parts, it is possible to read a change in the height of the electrode to a few 45/10000mm. The narrow arm of this resistance tube is used for measuring very high resistances, while the wider arm is used for smaller. By placing the unknown resistance behind the measuring resistance, or in shunt with it, it is possible to measure resistances varying from one hundred to thirty million ohms, within a few per cent.

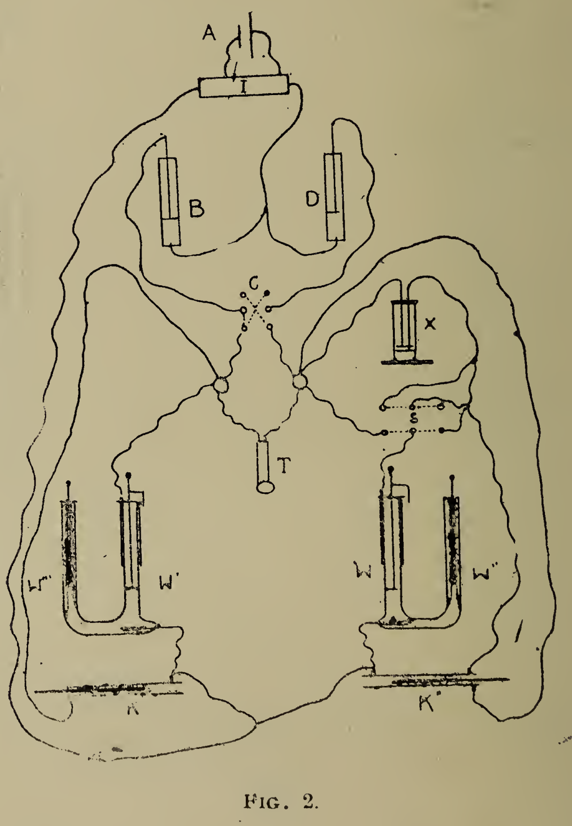


FIG. 2.

A 2/3-normal solution of mannite and boric acid, whose small negative temperature coefficient was compensated with potassium chloride (0.06g. per liter of the mannite solution), was used as the electrolytic resistance.

A diagram of the complete apparatus is shown in figure 2. A and I are the accumulator and induction coil. W, W′, W″ and W‴ are the arms of the bridge (W and W′ are 5 mm. in diameter, and W″ and W‴ are 0.8mm.); D and B are two resistances which remain constant during an experiment; K′ and K″ are variable condensers; T is the telephone; X is the cell for the unknown resistance; S is a two-way switch for introducing X behind W or in shunt with it, and C is a commutator used for making D and B equal.

The resistances W, W′, W″, and W‴ were calibrated by means of a known electrolytic resistance in the cell X. By using the same cell, for the acetophenone solutions of the substances under investigation, their resistances were readily calculated from the length of resistance W required to give a balance[1].

In order to test the accuracy of this method, the conductivity of a sample of ordinary distilled water, the conductivity of which was also measured by the Kohlrausch method, was determined. By the first method it was found that at 15°.0 $\kappa = 1{,}23\ 10^{-5}$, and by the second method, at the same temperature, that $\kappa = 1{,}17\ 10^{-5}$.

The acetophenone used in the following measurements was first purified by distillation and recrystallization. This acetophenone had a specific conductivity of $\kappa = 2{,}02\ 10^{-7}$.

The measurements given in the following tables were all made at room temperature (16-17°).

1. For a detailed description of the method, apparatus, etc., see Maltby, M. E. loc. cit.

TABLE I.

Conductivity of some Substances in Acetophenone.

Liter per Mol. V.	Spec. Conductivity corr. $\kappa . 10^7$	Mol. Conductivity corr. $\mu \cdot 10^4$
	Piperidine*	
2	5.37	10.74
4	4.54	18.16
8	3.76	30.08
	Camphor-carboxylic acid	
2	29.1	58.2
4	19.9	79.6
8	12.5	100.0
16	6.7	107.5
32	3.5	111.7
	Bromcamphor-carboxylic acid	
2.75	30.7	84.4
5.50	19.1	105.0
11.00	11.5	126.5
22.00	6.0	132.0
	Piperidine camphor-carboxylate	
2	172.4	344.8
4	87.6	350.4
8	50.8	406.4
16	30.8	492.8
32	18.3	585.6

* The acetophenoneused with piperdine had a specific conductivity of $\kappa = 2.87 . 10^{-7}$.

On account of the readiness with which acetophenone solutions of bromcamphor-carboxylic acid decompose in the presence of small quantities of organic bases[1], it was not possible to measure the conductivity of salts of this acid. In order to obtain some idea of the order of the conductivity of the salts of bromcamphor-carboxylic acid with weak bases, an acetophenone solution, which was 0.3305 molar with respect to acid and 0.0113 molar with respect to conine, was prepared and its conductivity immediately determined. The specific conductivity of this solution was found to be $65.0 \cdot 10^{-7}$; its molecular conductivity was, therefore, $196.6 \cdot 10^{-4}$.

The conductivities given in the foregoing table have been corrected for the conductivity of the solvent.

In the following table there is given the specific conductivity of half normal acetophenone solutions of a number of weak organic bases; the specific conductivity of half normal acetophenone solutions of the salts of these bases with camphor-carboxylic acid and, lastly, the specific conductivity of half normal water solutions and the dissociation constants of some of the bases. In this table the bases are placed in the order of their dissociation constants in water solution.

---

1. Creighton, H. J. M. : loc. cit.

TABLE II.

Base.	Half normal acetophenone solution. Spec. conductivity of the base. $\kappa.\ 10^7$. uncorr.	corr.	Spec. conductivity of the carboxylate. $\kappa.\ 10^7$. uncorr.	corr.	Half normal aqueous solution. Specific conductivity of the base[1]. $\kappa.\ 10^3$.	Dissociation constant[2] at 25° (water solution.) κ.
Aniline	2.13	very small.	38.1	36.1	....	$4.0 \cdot 10^{-9}$
Quinaldine	2.11	"	71.8	69.8	....	....
Quinie	2.79	0.77	88.5	86.7	....	....
Quinidine	2.83	0.81	88.2	86.2	....	....
Nicotine	3.72	1.70	258.4	256.4	....	....
Benzylamine	5.86	3.84	176.3	174.3	0.94	$2.4 \cdot 10^{-5}$
Triisobutylamine.	2 75	0.73	566.1	564.1	....	$2.6 \cdot 10^{-4}$
Diisobutylamine..	2 42	0.40	salt not	soluble.	....	$4.8\ 10^{-4}$
Isoamylamine. ..	6.82	4.80	salt not	soluble.	4.2	$5.0 \cdot 10^{-4}$
Tripropylamine ..	2.30	2.28	721.7	719.7	....	$5.5 \cdot 10^{4}$
Conine.	3.90	1.88	37.3	36.3	6.9	$1.3 \cdot 10^{-3}$
Piperidine	8.24[3]	5.37	175.3[3]	173.3	7.3	$1.6 \cdot 10^{-3}$

1. The numbers in this column have been obtained by extrapolation of measurements by G. Bredig (Zeitschr. f. phys. Chem. **13**, 289, 1894), after converting the values expressed in units based on Siemens unit into values expressed in the international unit.

2. Bredig, G.: loc. cit.

3. The acetophenone used with the piperidine preparation had a specific conductivity, $\kappa = 2.87 \cdot 10^{-7}$.

From the foregoing conductivity measurements, it will be seen that, where conductivities were measured at different dilutions, the molecular conductivities increased with dilution, as in aqueous solutions; that the "electrolytic dissociation"[1] of the above bases must be exceedingly small; and, also, that the "electrolytic dissociation" of their salts with camphor-carboxylic acid, although twenty to several hundred times greater, is still of the same small order. There is reason to believe that the salts of these bases with bromcamphor-carboxylic acid are probably "electrolytically dissociated" to a much greater extent.

It was hoped to have been able to determine the dissociation constants of the different bases in acetophenone solution, but this was found to be impossible, owing to the large errors introduced by the extreme smallness of the conductivities and the rapidity with which the specific conductivities of the solutions approached the specific conductivity of the solvent, even at small dilutions. From the last two columns of table 2, it will be seen that the specific conductivities of equi-molar aqueous solutions of benzylamine, isobutylamine, conine and piperidine, are relatively proportional to their dissociation constants. In view of this it is possible that the specific conductivities of equi-molar acetophenone solutions of the different bases, which are about ten thousand times smaller than for water solutions of the same concentrations, are also a measure of their dissociation constants in this solvent. From the measurements made it would appear, then, that the dissociation constants of the different substances employed are *very much smaller in acetophenone solution than in water.* This supposition is in harmony with the Nernst-Thomson rule, which shows clearly the close parallelism between the dielectric constant of the solvent and its dissociating power, since Walden has recently

1. Here by "electrolytic dissociation" and "electrolytically dissociated" are meant any condition of good electrolytic conduction, without necessarily assuming that the relations are as simple as those which occur in water solution.

found the dielectric constant of acetophenone[1] to have the small value of 18.1-18.6 at room temperature. It is further to be observed that if our conjecture be correct, namely, that with equi-molar actophenone solutions the specific conductivity is an approximate measure of the dissociation constant of the solute, then the relative strengths in acetophenone of the bases used above differ somewhat from those in water. Thus conine which, in water solution, is a stronger base than isoamylamine, for example, is weaker than the latter in acetophenone. On the other hand the relative position of piperdine is the same in either solvent.

The measurements embodied in this paper were carried out at the Laboratorium für electro und physikalische Chemie, der eidgenössischen technischen Hochschule, Zürich, Switzerland, in February, 1911, at the suggestion of Professor G. Bredig.

1. Walden, P. : Zeitschr. f. phys. Chem., **70**, 573, (1910).

Dalhousie University,
Halifax, Nova Scotia,
May 3rd, 1912.

Mastodon Remains in Nova Scotia.—By Harry Piers, Curator of the Provincial Museum, Halifax.

Read 13th May, 1912.

While recently engaged in preparing suitable labels for specimens of a femur and molar tooth of the American Mastodon from Cape Breton island, which are preserved in the Provincial Museum at Halifax, I was led to make inquiries to ascertain as far as possible just what was known regarding their history, either in literature or as tradition among the old people of the localities where they were discovered. It was found that little was on record, and in fact the precise spots where they were unearthed were not at all definitely known, and other points required clearing up.

In order to facilitate future reference, I now venture to present a concise systematized account of all that is known of the only authentic existing remains of the Nova Scotian Mastodon, including interesting particulars from old persons who still remember well the original discovery. The time for rescuing any unrecorded facts was almost gone, and in a few years not a man would have remained who could have personally recalled any of the circumstances of one of the most interesting palæontological finds ever made in this province.

At the outset it may be observed that the paper does not intend to deal with the question of geological age, but it may be stated that there seems no reason to question the generally accepted conclusions on this point.

The Mastodons, of which about thirty species have been described, belong to the suborder Proboscidea (the Elephants), primative forms of which lived in Egypt in the Middle Eocene, showing that Africa was the point of dispersion of the animals of this suborder. Mastodons made their appearance in Europe at least as early as the middle of the Miocene epoch and also

soon afterwards in Asia. From Asia they migrated to North America, and are there first met with in the Deep River and Loup Fork (Upper Miocene) beds of the central states. In the next ascending series, that of the Pliocene epoch, we find them still existing in Europe, Asia and North America (where they are rather common), and they then here found their way into South America. Finally in the Pleistocene epoch they are persisting and common in North America and have spread in South America, while they have disappeared from Asia and Europe, being there survived, as well as in Africa, by the existing genus *Elephas*. Some remains in the United States are said to have been found in association with stone implements, which if so, would indicate that there at least they must have survived till after the advent of man.

Name and Range.

Name and synonyms.—The species to which the Nova Scotian remains are referred, is the AMERICAN MASTODON, *Mastodon americanus* (Cuvier), which is considered to be synonymous with *M. ohioticus* (Blumenbach) and *M. giganteus*, Cuvier. As only a couple of members of a skeleton (a thigh-bone and a molar tooth) are known from Nova Scotia, their reference to this species must for the present be considered as probably, but not positively, correct.

Range of the species.—Remains of the species occur in various parts of North America as far south as Texas. They are more or less common in alluvial deposits such as occur on a small tributary of the Osage river, Burton county, Missouri, and in a peat deposit at "Big-bone-lick," Kentucky; also in Orange county, and near Cohoes falls on the Mahowk and elsewhere in the lower Hudson valley counties, New York; and likewise in Indiana, New Jersey, Ohio, and numerous other places. In Canada they have been reported from Ontario, Manitoba, the Yukon, and Nova Scotia.

Femur.

Description.—The first specimen in the museum is a right femur (thigh-bone) of an adult animal, agreeing generally in form with that of *M. americanus.* It is in a very good state of preservation, the bone tissues being firm and practically unaltered, but longitudinally cracked in a few places. Remains of the cartilege may still be seen on a few places on the articular surface of the head of the bone. In parts, particularly about the region of the extremities (trochanter major and the condyles) the outer surface is somewhat worn off, exposing the cellular under parts. In the vacinity of the internal trochanter a portion of the bone has been broken off.

Measurements.—Greatest length from head to inferior extremity near condyles, 3 ft. 10.50 in. Diameter of body of femur in middle, 7.35 in.; anterior-posterior diameter at same place, 4.60 in. Greatest width from head to region of trochanter major, 1 ft. 5.50 in. Diameter of head, 8 in.; diameter of neck, 6.40 in.; anterior-posterior diameter at last-mentioned place, 5.60 in. Diameter at condyles, 10 in.; anterior-posterior diameter at condyles, 7.75 in. These measurements would indicate an animal that would have measured about 10½ feet to the shoulders, which very nearly equals the height (11 feet) of Dr. J. C. Warren's immense Mastodon skeleton from Newburg, N. Y., now in Boston.

Locality where found, and collector's name.—Found by the late Alexander McRae, at a depth of about five inches from the surface, in meadow soil containing some sand, on "intervale land," on farm of said McRae (now owned by his nephews, Duncan and Daniel McRae), one-half a mile westward of the road at the schoolhouse, Lower (Settlement) Middle River, Victoria county, Cape Breton island, Nova Scotia.* The precise spot where the bone was found is close

* Hon. W. F. McCurdy of Baddeck, writes me that he thinks some of the farmers at Middle River thought it might benefit them if they were to cut a canal through a gravel bank and so change the course of the river. They accordingly made the canal with the result that the river cut away a large quantity of gravel, etc., and so revealed the Mastodon remains. Honeyman states the femur was ploughed up.

to the eastern bank of the Middle river, and $1\frac{1}{2}$ miles south 15° east (true bearings) of the junction of Leonard McLeod brook (Middle River) with the Middle river. Compare Geological Survey of Canada, Nova Scotia map sheet no. 13. (*Vide* information supplied by Duncan McRae, nephew of the original finder).

The oldest mention of the bone in a Mechanics' Institute inventory of about 1835, merely gives the locality as "the Island Cape Breton." The earliest label, in Dr. Honeyman's writing, of about 1870, states it was found at "Middle River, C. B." Honeyman in his *Giants and Pigmies* (p. 87) says it was ploughed up on the intervale of Walker's farm, at Middle River, about nine miles from its mouth. The McRae farm, however, where the bone was discovered, was never owned by a Walker, nor was there a Walker family settled there. Alexander McRae had inherited it from his father, and it is still possessed by McRaes.

Date of discovery.—The femur was found about 1834 or a few years earlier. One of the latest stick-labels on it, in Honeyman's writing, gives the date as 1842, but this is an error, as well as his statement in *Giants and Pigmies* that it was found about forty years before, that is about 1846. The first record I find of it is in a manuscript list of articles in the Halifax Mechanics' Institute (founded in 1831), undated, but written on paper watermarked "1833" and therefore prepared approximately about 1835, where it is entered as "Right thighbone of the Fossil Elephant found in the Island Cape Breton, [Presented by] Peter H. Clark, Esq." Then in a manuscript inventory of apparatus, models and specimens in natural history in the museum of the same institution, prepared by C. Creed in June, 1839, we find listed the "Femur of fossil Mastodon." An inspection of lists of donations to the Institute, usually given annually in the *Nova Scotian* newspaper, may fix the date. The late Alfred F. Haliburton, of

Baddeck, told me some years ago, that according to his recollection the date would be approximately about 1836.

Donor's name.—From Alexander McRae the specimen passed to Peter Hall Clarke of Sydney, afterwards (1844) a member of the legislative council, who presented it to the then recently organized Halifax Mechanics' Institute in whose museum it remained until it was transferred to the Provincial Museum of Nova Scotia on the latter's foundation in October, 1868, where it is still preserved.

Geological age.—This bone may be fairly safely assigned to the very close of the Pleistocene (or Glacial) epoch or the opening of the Recent (or Post-glacial) epoch. The underlying formation is carboniferous limestone.

Dawson in the first edition of *Acadian Geology* (1855) speaks of its having been found in superficial gravel, and says it probably belonged to the close of the glacial or drift period, and that the species was probably extict here before the introduction of man. Honeyman in his *Giants and Pigmies* (1887), pp. 87-89, states that he had hitherto held the opinion "that it was of post-glacial age, that it was contemporary with the American mammoth, both being of Pleistocene age and of the Champlain period," but on certain geological considerations he says he has now been led to regard it "as contemporary with the Europeans." Does he mean the European mastodons? Dawson in his *Handbook of Geology* (1889), p. 157, very slightly modifies his earlier view, and refers it to the post-glacial or late glacial age, "possibly" extinct before the introduction of man, though he rightly notes that the Micmac Indians seem to have had traditions of its existence.

Remarks.—Honeyman (*Giants and Pigmies*) says the discovery of this bone caused considerable excitement, and that Admiral Dundonald (who was on this station from 1848 to 1851) and Dr. Abraham Gesner visited and explored the spot with the expectation of making further discoveries of remains,

but without success.* As the place is thoroughly cultivated, it is exceedingly doubtful if mere superficial examination would disclose anything further, but it is quite possible that the subsoil may yet hide other parts of the skeleton.

References and figures.—Manuscript lists of articles in the Halifax Mechanics' Institute, *circa* 1835, and June, 1839. Dawson (Sir J. W.), Acadian Geology, 1st ed., 1855, pp. 57-58; 2nd ed., 1868, p. 83, with figure on p. 84; 3rd ed., 1878, do.; 4th ed. (Geology of Nova Scotia, etc.), 1891, do. Honeyman (Rev. D.), Giants and Pigmies, 1887, pp. 87-88. Dawson (Sir J. W.), Handbook of Geology, 1889, p. 157. McRae (Duncan), information in manuscript furnished by him, February, 1912.

Molar Tooth.

Description.—The tooth is a molar, probably a second one, but I am not able to say whether it is from the right lower or the left upper maxilla. It has three well defined transverse "nipple ridges" on the crown, but with very inconspicuous tubercles thereon, and no cement in the hollows of the enamel, etc. The roots or "fangs" are two, the anterior one much smaller than the posterior one. In the latter, which has perhaps been slightly broken or eroded at the apex, is the nerve and artery canal open at the apex of the root and bifurcating at the inner extremity where it communicates with the pulp-cavity. The enamel is jet black externally, and white within. The black layer occupies from nearly nothing to about one-quarter of the total thickness of the enamel. The dentine is of cream colour. The tooth was in good preservation when found, but unfortunately the finders undertook to investigate its structure with the aid of a blacksmith's hammer and vice, and so

*D. J. Mc Rae of Baddack, a relative of Alexander, says that in 1850 Admiral Dundonald with his ship was in the Bras d'Or. and having heard of the finding of the Mastodon remains, went to Middle River with a number of his sailors, and that the Admiral took away to England a broken "tooth" (tusk ?) which had been found there but that it was afterwards returned to Nova Scotia. While this fixes the time o Dundonald's visit, there can be little or no doubt that the tusk from Middle River was taken from there prior to 1835. See remarks on the Tusk

succeeded in breaking off part of one of the end transverse ridges, as well as about half of the enamel, thus leaving the yellowish dentine of the crown exposed. Otherwise it is in excellent condition.

Measurements.—Greatest length of crown, 4.35 ins.; greatest width of crown, 3.10 ins.; summit of posterior transverse ridge to apex of larger root, 3.90 ins.; summit of anterior transverse ridge to apex of smaller root, 2.80 ins.; height of crown from summit of transverse ridges to base of roots, 1.60 in.; greatest height of transverse ridges (apices broken off), .75 in., but original height probably 1.10 in.; thickness of enamel, .16 in.; depth of nerve canal to its bifurcation, 1.30 in.; greatest diameter of nerve canal at exterior opening, .50 in.

Locality where found, date, and collector's name.—Found in 1859 at Baddeck, Victoria county, on the northwestern side of Little Bras d'Or lake, Cape Breton island (*vide* Dr. Honeyman's original label). This is 8½ miles east-southeast of the place where the femur was discovered. I had suspected that possibly the tooth might have been obtained at the latter place and carried to Baddeck, but Duncan McRae assures me that he never heard of such a tooth having been found on his farm at Lower Middle River. It was presumably found by a resident of the district, but his name is not now known. Dawson is in error in saying it was discovered by Dr. Honeyman. Strange to say, Hon. W. F. McCurdy, of Baddeck, writes me that he has been unable to find anyone who now knows anything of such a tooth having been found at Baddeck or Baddeck river.

Donor's name.—Dr. Kier of Princetown, Prince Edward Island, obtained it from the finder, and shortly prior to 1862 gave it to Dr. Honeyman, who deposited it in the Provincial Museum in 1868, where it is still preserved.

Geological age.—Doubtless precisely the same as in the case of the femur.

Remarks.—The size of the tooth indicates that it belonged to an individual smaller than that from which the femur was derived. These specimens therefore show that two Mastodons at least existed in Cape Breton island, no doubt both belonging to the same species. The tooth was shown by Dr. Honeyman in the Nova Scotian palæontological collections of the exhibition at South Kensington, England, in 1862, and he then compared it with many teeth of *M. americanus* in the British Museum, with which it agreed.

References and figures.—Dawson (Sir J. W.), Acadian Geology, 2nd ed., 1868, p. 83, with figure showing outer side, reduced to about half natural size, on p. 84; also in subsequent editions. Honeyman (Rev. D.), Giants and Pigmies, 1887, p. 88.

Tusk.

Tusk.—In the beforementioned manuscript list of articles in the Halifax Mechanics' Institute museum, prepared about 1835, there is listed a "Large tooth of some unknown animal found in Island Cape Breton, presented by Mr. Le[o]nard," as well as the right thigh-bone already described. In Creed's inventory of June, 1839, we find "Femur of fossil Mastodon; tooth of do. do.," and Dr. Honeyman has written opposite the "tooth," *not found,* that is when he took over the museum in 1868.

Dawson (*Acadian Geology,* 1st ed., 1855, p. 57) says that the thigh-bone in the museum of the Mechanics' Institute and some fragments of a tusk were the only remains of the Mastodon he had up to then actually seen in the province, and furthermore states that he had not seen any teeth. As Dawson was very familiar with the contents of the Institute museum, there can be no doubt that he considered the so-called tooth to be fragments of a tusk or highly developed upper incisor tooth of the animal.

Honeyman (*Giants and Pigmies*, 1887, p. 88) states that he found in the Mechanics' Institute museum tusks which were supposed to be parts of the Mastodon tusks, but which he says were tusks of the walrus. It seems almost positive that he was in error about this, and that the original tusk had been lost, or loaned for examination and never returned, prior to his taking over the collections in 1868, and that he had come to the conclusion that one of the walrus tusks which he later found in the museum must have been mistaken for it.

That a tusk or part of a tusk was actually found on the McRae farm at Lower Middle River, Victoria county, is very strongly supported by Duncan McRae (memorandum of February, 1912) who distinctly remembers that a "large tooth [i. e., tusk] shaped somewhat like a sickle" was found on the McRae farm a short distance from where the thigh-bone was discovered, and I suppose at or about the same time, and that a man whose name he does not know, who had been sent down from Halifax, went there and took it away to Halifax. It was so large that this man, when he departed with it, "slung it across his shoulder," but the incident took place so long ago that McRae does not remember the exact length of the relic. This, in my opinion, was without doubt the tusk or "tooth" which was afterwards in the Institute museum, presented by a Mr. Leonard, listed in the beforementioned inventories, seen by Dawson prior to 1855, but which was lost before 1868. The sickle-shape shows it was a long "tusk," not an ordinary molar tooth. McRae says he had never heard of anything else resembling a tooth having been found at Lower Middle River, nor any other remains but the thigh-bone. The Mr. Leonard mentioned as having presented the so-called "tooth" to the Institute museum, was very likely Charles E. Leonard who was prothonotary, etc., of Sydney in 1833, or some other member of that family.

Other Remains.

Dawson (*Acadian Geology,* 1st ed., 1855, p. 58) says that while the femur and tusk fragments were the only remains he had then seen in the province, yet he was informed that others had been found, though several of the best specimens had unfortunately been lost by shipwreck.

The late Alfred F. Haliburton of Baddeck, Victoria county, sergeant-at-arms of the house of assembly, assured me, about 1901, that he was with those who brought away the Mastodon remains or some of them in a canoe from Middle River. I distinctly understood him to refer to that locality when he was speaking, and he thought the date would be about 1836 according to his recollection. He said they also had a skull or part of a skull of the animal, but it was lost by the upsetting of the heavily-laden canoe, presumably in the Middle river. It would seem as though this was what Dawson referred to when he said that some of the best specimens had been "lost by shipwreck." Duncan McRae, however, writes me that he does not remember ever having heard of this skull or of any specimens having been thus lost, the only remains he recalls being the femur and the "sickle-shapel tooth" as he calls it.

The Possibility of finding other Remains.

One purpose of this paper has been to draw attention to the advisability of making search here for further remains of the Mastodon, as well as to make a systematic record of all the obtainable information regarding such as have been already discovered.

It seems hardly possible that we have already discovered the only existing remains of the Mastodon that are in the province, and it would be well if we were to carefully investigate every reported case, that may come to our knowledge, of large bones being found anywhere, particularly at a distance from the sea, as at the latter remains of cetaceans are often met with. While the island of Cape Breton naturally suggests

itself as a most promising field for search,—and perhaps, as some have supposed, the reported lesser glacial erosion there might be a favourable factor,—yet the whole province should not be neglected.

A Micmac Indian, known as "Dr. Lone Cloud" or Jerry Bartlett, informs me that about 1874 a very old Indian woman, Magdalene Pennall of Sissiboo (Weymouth), Digby county, informed him that there had then been long known to her people certain very large rib-bones, which they supposed to be "whale ribs," on the barrens about two or three miles south-eastward of Blue Mountain lake, about twenty-five miles from the sea, in the northeastern part of Yarmouth county, N. S. The place is a very short distance east of Bloody creek or brook (a tributory of the Clyde river) and on a trail from that creek via Long lake, to the head-waters of the Shelburne or Roseway river to the eastward. On one occasion, Mrs. Pennall and her husband, Joe (Kophang), just after having left their canoe on Bloody creek, killed a moose at the spot where the bones were, and as a thunder shower came on they stood three of the large ribs against a rock, covered them with the moose-hide, and so formed a shelter. Some of the ribs which were on the ground were covered with a thick mantle of moss. Lone Cloud thinks there may have been some vertebræ there also, but knew of no other kinds of bones. Once some Indians carried away one of these big ribs, but as it was very heavy it was at last dropped, and the superstitious Indians affirmed that it was afterwards found once more in its original place, which caused the remains to be regarded with some veneration by members of the tribe.

The same Indian was also informed by John Jadis, a venerable and well-known Indian still living at Enfield, that very many years ago there were found at the Horne settlement at the outlet of Grand lake, Hants county, twenty-six miles from the sea and in the very heart of the province, some large vertebræ which were thought by the old inhabitants of the

district to be parts of a whale's backbone, and they were used as little stools to sit on. These have long ago disappeared, and the present Hornes know nothing of them. What particularly puzzled the Indian was, how "whale bones" could get to such inland places as the two just mentioned.

I have never seen these so-called whale bones, but one naturally ventures the opinion that possibly they may have been Mastodon remains, and that those traversing our waste-lands, as well as those cultivating surface deposits, should keep a sharp look-out for any such large bones, particularly at a distance from the sea, and should any be discovered some authority's opinion as to their identity should by all means be obtained.

A supposed Mastodon's skull was recently found on the shore of the Bras d'Or lake and was forwarded to the museum of the Provincial Normal College at Truro. This immediately aroused interest, but on examining photographs of it, I identified it as the cranium of a cetacean, the Black Fish (*Globicephalus melas*).

Halifax, N. S.,
13th May, 1912.

PHENOLOGICAL OBSERVATIONS IN NOVA SCOTIA, 1911.—By A. H. MACKAY, LL. D., F. R. S. C., Halifax.

(Read May 13, 1912.)

The phenochrons of the ten phenological regions of Nova Scotia were published in the Proceedings of the Royal Society of Canada, from those of 1902 to those of 1909, and in the Transactions of the Nova Scotia Institute of Science up to those of 1904. Phenological dates from a few or more stations were commenced to be published annually in both from the year 1892, including later, phenological dates from observation stations throughout Canada.

The most exact observations have been made through the schools of Nova Scotia, the pupils on their daily way to and from school reporting competitively to the teachers the first "finds." The object at first was the stimulation of Nature Study in the schools. But the multitude of observers every day at work, and the accurate checking of the observations by the teachers, made the school work not only fuller in quantity and more continuous in time, but practically as accurate as those made by scientific observers.

The schedules from each school are sent in by the teachers to the inspectors who transmit them to the Education Office, where they are bound in annual volumes and presented to the Provincial Science Library archives for the use of future students of climate problems. Three hundred or more of the best schedules are thus each year selected for permanent record. This selection has for many years been done by a staff of compilers who compute the phenochrons (average phenological dates) for the subsections of each region, so as to show the effect of the coast line and altitudes in each region.

These sheets of phenochrons are also bound up annually and deposited with the volumes of the fundamental schedules. The system of dating adopted is the annual instead of the usual mensual dates, on account of simplicity in the computation of the phenochrons.

As some of the regional schedules of 1910 have been accidentally misplaced, the general table of regional phenochrons is not yet ready for printing, and may simply be bound up for the archives. The regional table for the calendar year 1911 have been compiled by Mr. John Burris Reid, clerk in the Education office, and is published here rather to advertise the fact that the original local schedules and sub-regional phenochrons are available for any special studies of Nova Scotian phenology. To explain the table, the following instructions to compilers of the "belt" and "region" phenochrons are repeated.

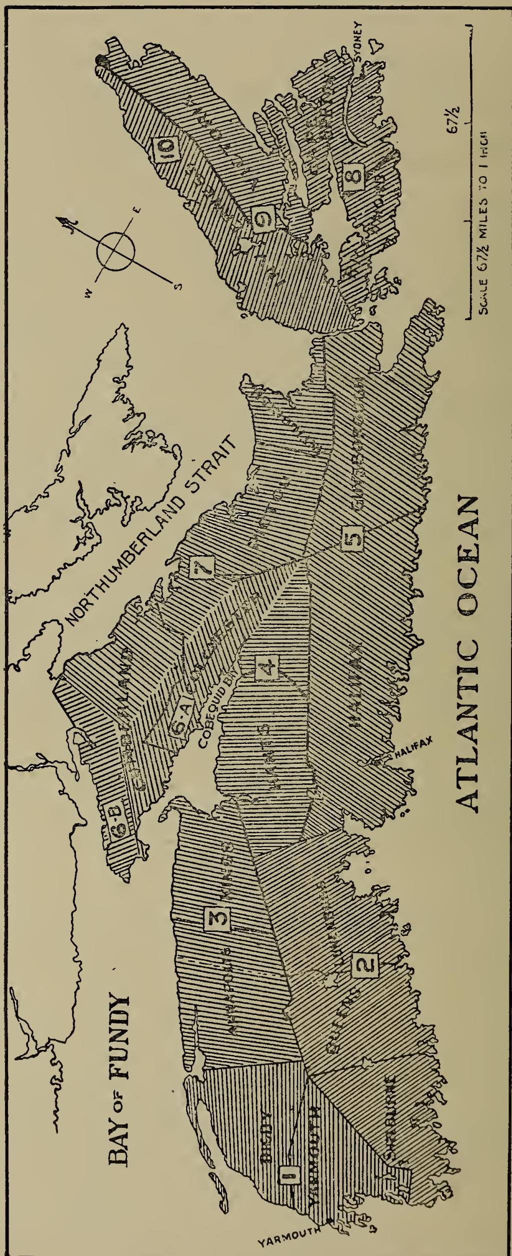
"A province may be divided into its main climatic slopes or regions which may be seldom coterminous with the boundaries of counties. Slopes, especially those to the coast, should be subdivided into belts such as (a) the coast belt, (b) the low inland belt, and (c) the high inland belt.

In Nova Scotia the following regions are marked out, proceeding from north to south, and from east to west, as orderly as possible:

No.	Regions or Slopes.	Belts.
1.	Yarmouth and Digby Counties.	(a) Coast, (b) Low Inlands, (c) High Inlands.
2.	Shelburne, Queens and Lunenburg Counties	(a) Coast, (b) Low Inlands, (c) High Inlands.
3.	Annapolis and King's Counties.	(a) South Mts., (b) Annapolis Valley, (c) Cornwallis Valley, (d) North Mts.

No.	Regions or Slopes.	Belts.
4.	Hants and Colchester, South of Cobequid Bay	(a) Coast, (b) Low Inlands, (c) High Inlands.
5.	Halifax and Guysboro Counties.	(a) Coast, (b) Low Inlands, (c) High Inlands.
6.	(A) Cobequid Slope to S. (B) Chignecto Slope to N. W....	(a) Coast, (b) Inlands.
7.	Northumberland Straits Slope, (to the North)	(a) Coast, (b) Low Inlands, (c) High Inlands.
8.	Richmond and Cape Breton Counties	(a) Coast, (b) Low Inlands, (c) High Inlands.
9.	Bras d'Or Slope (to S. E.)....	(a) Coast, (b) Low Inlands, (c) High Inlands.
10.	Inverness Slope (to Gulf N. W.).	(a) Coast, (b) Low Inlands, (c) High Inlands.

[*When the belts* (b) *and* (c)—*Low and High Inlands—are not sufficiently distinct, they may be combined in any "region" into one* (*belt* b c)—*Inlands. There will then be but two belts to be considered "Coast" and "Inlands."*]



THE TEN PHENOLOGICAL REGIONS OF NOVA SCOTIA.

Averaging Local Phenochrons for "Region" or "Belt" Phenochrons.—If ten or fewer good phenological observation schedules can be selected from those belonging to any given belt, they may be averaged as indicated in the columns within. If there are not ten from each belt, then it may be better to combine two belts, or if necessary, three belts on the form within. In the latter case the average will be the "region" phenochrons. When a full sheet can be made out for each belt, the average of the phenochrons for the three "belts" will give the phenochrons for the "region." Finally, the phenochrons of each of the ten regions will be averaged to find the provincial phenochron for each phenomenon on the list. This will be done by the compiler-in-chief.

There is a convenience in averaging the dates of ten stations, which accounts for the ten columns for stations in the form* within. When a few dates are not given it may be fair to enter in the blanks* the dates from a similar and neighboring station which is not otherwise utilized for the sheet. Great care should be taken that such observations taken from a schedule not summarized, should be what might have been observed at the station indicated in the heading, and to indicate such a transference the date should be surrounded by a circle with the pen, which would always means that the observation was not made in the station heading the column,* but in a neighbouring one, and was taken from a supernumerary schedule.

Thunder-Storms.—These dates will be entered in their respective columns and opposite the month indicated. They will not be averaged, of course. The number of observation schedules represented in any "region" or general sheet under this head should be noted somewhere on the top margin of the page.

Accuracy.—Care must be exercised in selecting schedules, the observations of which appear to have been carefully made,

---

*Footnote on p. 180.

neglecting any which give reason for doubt, when selecting for summation on the form* within. Great care must also be exercised in copying the figures and entering them, so that no slip may occur. Every entry should be checked. One slip may spoil the effect of all the accurate numbers entering into the summation. In like manner great care has to be taken in adding and averaging the figures, and for this purpose every sum should be done twice (once in reverse order), so as to give absolute confidence in the accuracy of the work.

Remarks.—The compiler filling one of these blanks* should keep one copy for himself while sending the other to the compiler-in-chief.

The set of stations on the right under "when becoming common," must be *exactly* the same as on the left, under "when first seen." The compiler can enter explanatory remarks in the blank* below, and should sign each sheet as a guarantee of its correctness. These sheets* will be bound into a volume for each year."

*These words refer to the ruled and printed blank forms into which the compilers enter the averages, which are finally compiled into the same blank form as exhibited in the following table.

Nomenclature as in GRAY'S or SPOTTON'S MANUAL.

FLOWERING AND OTHER PHENOCHRONS FOR THE PROVINCE OF NOVA SCOTIA, 1911.

[COMPILED FROM ABOUT 300 PUBLIC SCHOOL OBSERVATION SCHEDULES. THE DECIMAL FRACTIONS ARE OMITTED ON ACCOUNT OF THE SMALL SPACE IN THE REGIONAL PHENOCHRONS].

YEAR ENDED DECEMBER, 1911.

Day of the year corresponding to the last day of each month.

Jan.	31	July	212
Feb.	59	Aug.	243
March	90	Sept.	273
April	120	Oct.	304
May	151	Nov.	334
June	181	Dec.	365

For Leap Year add one to each except January.

WHEN FIRST SEEN. — REGION.

		1. Yarmouth and Digby.	2. Shelburne, Queens, and Lunenburg.	3. Annapolis and Kings.	4. Hants and South Colchester.	5. Halifax and Guysboro.	6. South Cobequid Slope (S. Cumb. and Col.)	7. North Cumb., Col., Pictou and Antig.	8. Richmond and Cape Breton.	9. Bras d'or Slope (to South East).	10 Inverness Slope (to Gulf N. W.)	Average Dates.
1	Alnus incana, Wild	108	108	111	117	113	123	114	122	112	111	114.2
2	Populus tremuloides	....	114	118	116	118	120	121	128	126	...	120.9
3	Epigea repens, L	96	104	106	111	121	111	118	119	119	115	112.4
4	Equisetum arvense	128	129	126	130	135	131	129	143	132	....	132.3
5	Sanguinaria Canadensis	....	....	133	141	130	126	127	....	....	....	131.6
6	Viola blanda	120	123	124	128	127	125	128	132	128	129	126.8
7	Viola palmata, *cucullata*	123	127	127	131	132	129	130	135	131	132	130.1
8	Hepatica triloba, etc.	118	123	140	135	122	....	148	156	....	....	134.8
9	Acer rubrum	125	124	123	129	129	132	128	140	132	118	128.5
10	Fragaria Virginiana	124	125	125	131	130	127	129	135	128	131	129.0
11	" " fruit ripe	155	155	154	161	165	156	160	176	174	164	162.4
12	Taraxacum officinale	125	129	128	134	134	131	133	137	135	131	132.1
13	Erythronium Americanum	131	151	140	147	152	134	135	160	....	....	144.0
14	Coptis trifolia	129	131	134	137	135	134	134	137	140	132	134.7
15	Claytonia Caroliniana	....	...	139	143	134	129	124	146	127	133	134.7
16	Nepeta Glechoma	145	133	134	138	142	137	136	169	142	132	144.1
17	Amelanchier Canadensis	135	130	131	138	139	134	133	144	146	135	136.8
18	" " fruit ripe	....	178	177	196	181	....	....	....	....	...	183.3

WHEN BECOMING COMMON. — REGION.

		Average Dates	1. Yarmouth and Digby.	2. Shelburne, Queens, and Lunenburg.	3. Annapolis and Kings.	4. Hants and South Colchester.	5. Halifax and Guysboro.	6. South Cobequid Slope (S. Cumb. and Col.)	7. North Cumb., Col., Pictou and Antig.	8. Richmond and Cape Breton.	9. Bras d'or Slope (to South East).	10. Inverness Slope (to Gulf N. W.)
1	Alnus incana, Wild	120.5	118	111	118	127	118	132	118	126	119	114
2	Populus tremuloides	126.5	...	121	122	122	122	124	129	135	132	....
3	Epigea repens, L	120.9	111	114	114	120	123	121	124	130	127	121
4	Equisetum arvense	137.7	135	134	128	137	140	140	133	150	139	...
5	Sanguinaria Canadensis	135.4	...	...	135	139	137	133	132	....	....	....
6	Viola blanda	132.8	128	128	130	135	133	134	133	137	134	131
7	Viola palmata, *cucullata*	135.8	130	131	133	139	137	136	135	141	138	133
8	Hepatica triloba, etc.	136.5	123	128	122	141	130	...	153	158	....	...
9	Acer rubrum	133.3	133	130	129	134	132	130	132	147	138	125
10	Fragaria Virginiana	137.2	133	131	133	142	138	139	136	142	141	134
11	" " fruit ripe	171.7	169	164	163	173	174	169	169	183	183	167
12	Taraxacum officinale	138.2	134	135	134	141	140	140	139	142	141	133
13	Erythronium Americanum	149.2	135	159	145	153	157	141	139	164	....	....
14	Coptis trifolia	140.4	136	136	138	143	140	143	139	145	145	136
15	Claytonia Caroliniana	139.8	....	...	141	148	139	137	129	149	133	140
16	Nepeta Glechoma	146.7	152	138	140	142	148	146	141	174	148	136
17	Amelanchier Canadensis	142.1	141	134	134	143	143	142	137	150	152	141
18	" " fruit ripe	184.3	....	181	180	189	....	....	....	....	....	...

FLOWERING AND OTHER PHENOCHRONS FOR THE PROVINCE OF NOVA SCOTIA, 1911—(*Continued*).

Year Ending December, 1911.

Day of the year corresponding to the last day of the month.

Jan.	31	July	212
Feb.	59	Aug.	243
March	90	Sept.	273
April	120	Oct.	304
May	151	Nov.	334
June	181	Dec.	365

For Leap Year add one to each except January.

When First Seen. Region.														When Becoming Common. Region.									
1. Yarmouth and Digby.	2. Shelburne, Queens, Lunenburg.	3. Annapolis and Kings.	4. Hants and South Colchester.	5. Halifax and Guysboro.	6. South Cobequid Slope (S. Cumb. and Col.)	7. North Cumb., Col., Pictou and Antig.	8. Richmond and Cape Breton.	9. Bras d'or Slope (to South East).	10. Inverness Slope (to Gulf N.W.)	Average Dates.			Average Dates	1. Yarmouth and Digby.	2. Shelburne, Queens, and Lunenburg.	3. Annapolis and Kings.	4. Hants and South Colchester.	5. Halifax and Guysboro.	6. South Cobequid Slope (S. Cumb. and Col)	7. North Cumb., Col. Pictou and Antig	8. Richmond and Cape Breton.	9. Bras d'or Slope (to South East).	10. Inverness slope (to Gulf, N. W.)
135	131	133	142	142	138	137	151	150	140	140 6	19	Prunus Pennsylvanica	146.1	141	138	137	145	147	144	141	157	156	142
....	195	167	222	....	229	245	....	218	...	212.6	20	" " fruit ripe	232.4		208	....	233	....	240	255	....	226	....
133	134	132	144	144	139	136	152	147	131	139.5	21	Vaccinium Can. and Penn	146.2	143	140	140	148	149	146	145	158	154	136
180	177	184	174	....	163	180	216	219	....	187.0	22	" " fruit ripe	202.7	....	215	213	214	....	164	155	222	235	...
145	146	144	149	151	147	150	158	159	156	150.9	23	Ranunculus acris	157.7	151	152	150	156	160	156	155	164	164	165
144	151	150	153	157	158	157	163	161	....	155.3	24	R. repens	159.8	149	156	155	159	164	157	160	168	168	....
144	144	140	144	149	138	144	....	147	135	143 0	25	Trill. erythrocarpum	149.8	149	149	145	150	157	145	148	....	153	....
137	138	140	141	146	144	140	149	....	143	142 5	26	Rhododendron Rhodora	147.0	144	142	143	146	152	146	144	155	....	147
146	144	145	149	149	145	146	158	153	158	149.7	27	Cornus Canadensis	156.2	152	150	150	154	155	152	155	164	158	167
....	193	...	209	..	163	....	....	225	....	197 5	28	" " fruit ripe	212.0	....	207	....	231	....	182	...	....	230	....
143	143	137	146	149	143	146	157	154	139	146.1	29	Trientalis Americana	151.7	147	148	140	151	153	152	149	163	160	148
145	149	146	153	157	148	152	...	157	...	151.6	30	Clintonia borealis	156.9	152	154	151	164	163	152	154	..	163	....
147	152	148	154	163	163	154	166	169	..	157.6	31	Calla palustris	162.5	154	159	155	160	167	163	159	170	174	...
149	147	149	159	161	151	153	164	172	151	156.0	32	Cypripedium acaule	161.7	157	151	152	166	163	159	158	170	177	....
150	150	146	151	159	157	156	166	170	155	156 4	33	Sisyrinchium angustifolium	162.4	157	154	151	159	166	165	160	172	177	150
159	153	159	164	166	167	161	177	170	157	164.3	34	Linnæa borealis	168.5	166	160	162	170	170	168	165	179	174	166
149	150	144	151	155	144	144	158	....	153	150 5	35	Kalmia glauca	157.9	158	154	149	156	161	149	149	163	...	179
158	155	153	158	158	155	162	162	...	152	157.3	36	Kalmia angustifolia	163.9	164	161	161	166	162	156	167	167	..	166
152	149	147	152	151	159	154	164	..	....	153 9	37	Crataegus oxyacantha	160.1	161	154	151	155	157	169	163	168	..	....
152	147	146	148	150	151	147	158	166	....	152.1	38	Crataegus coccinea, etc.	156.2	159	152	150	150	151	157	151	161	173	....
155	156	156	162	168	165	162	175	170	158	163.0	39	Iris versicolor	168.3	161	162	162	168	172	169	166	179	174	165

157	157	153	158	166	158	160	182	174	163	163.2	40	Chrysanthemum Leucanthemum..	170.2	166	163	160	166	172	169	167	190	179	166
149	153	159	165	162	159	160	174	177	165	162.6	41	Nuphar advena	168.9	162	162	161	170	171	164	165	182	182	167
156	150	148	153	158	157	152	167	167	145	155.7	42	Rubus strigosus	162.6	161	157	158	160	165	167	159	172	172	152
176	189	177	193	....	183	181	215	209	....	190.7	43	" " fruit ripe.......	211.9	....	217	204	216	..	195	..	223	216	. ..
159	167	170	175	175	147	168	..	180	....	168.0	44	Rhinanthus Crista-galli	172.0	169	173	172	175	178	154	168	..	185	
155	157	155	160	163	164	162	171	178	147	161.6	45	Rubus villosus	168.7	163	162	162	168	171	171	166	180	182	160
....	208	243	238	240	194	..	251	237	....	230.2	46	" " fruit ripe.........	236.2	...	219	244	243	243	202	.	256	246	....
159	157	157	158	168	163	159	177	175	....	163.8	47	Sarracenia purpurea	168.1	167	163	160	165	174	159	163	180	180	....
169	163	167	168	169	169	167	178	180	....	170.3	48	Brunella vulgaris	175.2	167	169	173	174	173	178	171	180	189	....
173	173	168	171	177	172	173	184	201	....	166.1	49	Rosa lucida......	171.2	178	177	173	176	178	180	176	194	206	....
159	162	163	174	167	163	164	200	172	....	158.6	50	Leontodon autumnale	165.4	168	168	170	186	174	164	169	210	177	....
160	156	168	172	130	166	166	211	...	....	155 1	51	Linaria vulgaris	175.1	169	165	174	177	142	194	167	216	....	....
129	127	126	131	137	131	128	139	142	140	133 3	52	Trees appear green	141.4	136	138	135	142	145	139	137	146	152	...
140	135	136	141	143	141	136	154	141	142	141.2	53	Ribes rubrum (cultivated)..........	147.3	146	140	140	145	150	148	140	161	146	155
....	181	173	183	145	185	188	180	214	....	180.5	54	" " (fruit ripe).........	195.7	....	197	175	202	....	190	198	184	223	..
143	140	137	143	145	144	138	154	150	151	148.8	55	R. nigrum (cultivated)	150.1	149	144	143	148	152	148	142	162	153	155
....	185	....	175	....	185	189	206	219	....	193.2	56	" fruit ripe	197.6	...	209	168	180		192	200	209	225	....
136	136	132	142	150	141	140	158	....	143	142.4	57	Prunus Cerasus......................	147.6	141	142	137	147	155	145	144	164	....	151
....	210	166	171		210	207	...	....	....	193.1	58	" " fruit ripe..	203.2		220	172	196	....	216	210	....	....	....
137	137	136	144	148	143	141	161	148	145	144.4	59	Prunus domestica	149.8	145	142	141	151	154	145	143	166	158	149
143	139	139	144	148	145	141	161	151	144	145.9	60	Pyrus Malus	151.6	150	144	145	151	153	153	145	167	157	147
149	146	145	149	157	151	147	164	164	156	153.2	61	Syringa vulgaris	158.8	156	151	149	155	164	159	152	169	169	161
153	157	152	156	162	158	160	169	172	153	159 6	62	Trifolium repens..................	166.7	163	163	158	163	170	168	169	174	176	159
145	151	151	157	161	159	160	171	170	158	158.6	63	Trifolum pratense	165.8	156	158	158	165	169	171	167	176	176	160
166	167	160	165	168	165	169	172	186	170	169.1	64	Phleum pratense....................	179.2	177	171	165	185	176	179	178	177	202	181
178	179	170	170	170	177	179	198	202	. ..	169.5	65	Solanum tuberosum	188.6	185	188	183	184	172	185	....	200	209	....
106	119	120	127	126	127	128	123	122	124	122.6	66	Ploughing first of season...........	129.1	114	127	126	136	131	135	134	129	127	128
115	122	129	134	133	129	132	138	140	135	131.1	67	Sowing	137.5	120	131	137	140	138	136	140	146	143	141
116	123	132	134	132	133	133	129	127	130	129.1	68	Potato planting	136.3	122	131	140	144	140	140	143	136	130	135
123	137	126	135	134	132	134	126	117	119	128.6	69	Sheep-shearing	137.5	136	145	138	143	139	137	143	139	126	126
176	180	182	199	189	192	196	204	208	....	191.8	70	Hay-cutting	202.9	183	196	194	211	207	197	202	221	214	....
....	226	234	239	241	244	235	241	245	....	238.3	71	Grain-cutting	246.7	238	235	250	254	248	250	240	255	249	....
250	265	258	267	276	272	271	278	274	300	271.3	72	Potato-digging	277.3	258	281	268	280	291	276	277	285	278	....
89	90	87	91	101	93	92	112	98	99	95.4	73a	Opening of rivers											
99	112	91	107	113	112	112	120	108	99	107.5	73b	Opening of lakes											
113	112	108	112	111	114	113	109	119	105	112.0	74a	Last snow to whiten ground.......											
123	122	120	120	117	121	123	121	128	121	122 1	74b	" to fly in air....											
128	130	124	132	136	131	139	131	122	131	130.7	75a	Last spring frost—hard											
138	139	124	164	152	138	156	151	167	156	148 7	75b	" " —hoar											
120	107	100	122	92	82	83	....	96	....	104.3	76a	Water in streams—high											
170	241	206	189	164	223	154	....	272	163	198.2	76b	" " low											
...	252	231	252	244	253	275	261	249	339	262.1	77a	First autumn frost, hoar											
305	264	263	287	270	278	297	294	325	....	287.2	77b	" " hard											
298	308	289	288	280	293	279	285	285	321	292.9	78a	First snow to fly in air											
318	320	308	315	310	331	309	325	320	....	317.7	78b	" whiten ground											
339	339	349	....	329	....	333	330	338	339	337.1	79a	Closing of lakes											
....	....	....	347	....	....	299	352	356	....	338 7	79b	" rivers											

FLOWERING AND OTHER PHENOCHRONS FOR THE PROVINCE OF NOVA SCOTIA, 1911—(*Continued*).

When First Seen. Region.											Year Ending December, 1911.	When Becoming Common. Region.										
1. Yarmouth and Digby.	2. Shelburne, Queens, Lunenburg.	3. Annapolis and Kings.	4. Hants and South Colchester.	5. Halifax and Guysboro.	6. South Copequid Slope (S. Cumb. and Col.)	7. North Cumb., Col., Pictou and Antig.	8. Richmond and Cape Breton.	9. Bras d'or Slope (to South East).	10. Inverness Slope to Gulf (N.W.)	Average Dates.	Day of the year corresponding to the last day of the month. Jan 31, Feb 59, March 90, April 120, May 151, June 171, July 212, Aug. 243, Sept. 273, Oct. 304, Nov. 334, Dec. 365. For Leap Year add one to each except January.	Average Dates	1. Yarmouth and Digby.	2. Shelburne, Queens, and Lunenburg.	3. Annapolis and Kings.	4. Hants and South Colchester.	5. Halifax and Guysboro.	6. South Cobequid Slope (S. Cumb. and Col.)	7. North Cumb., Col. Pictou and Antig.	8. Richmond and Cape Breton.	9. Bras d'or Slope (to South East)	10. Inverness slope (to Gulf, N.W.)
182	81	89	93	89	77	81	91	103	104	89.2	81a Wild ducks migrating, N...											
300	....	326	312	291	293	295	281	294	362	306.2	81b " " S..											
83	86	79	79	79	77	81	76	97	...	82.3	82a " geese " N..........											
312	307	312	323	306	262	286	....	287	....	299.6	82b " " S..........											
84	85	85	85	95	113	91	118	95	...	94.9	83 Melospiza fasciata, North											
81	81	82	83	81	89	84	93	96	100	87.3	84 Turdus migratorius "											
88	88	94	88	77	96	98	97	98	...	91.9	85 Junco hiemalis "											
107	123	138	140	131	128	132	...	129	....	128.8	86 Actitis macularla "											
...	107	131	120	127	....	152	172	...	....	135.0	87 Sturnella magna "											
125	127	134	124	120	128	127	133	125	128	127.6	88 Ceryle Alcyon "											
109	127	140	141	127	133	139	140	133	....	132.4	89 Dendroeca coronata "											
127	133	134	136	141	135	143	175	140	....	140.8	90 D. aestiva "											
139	119	136	130	125	[illegible]	116	140	124	...	126.0	91 Zonotrichia alba "											
138	115	141	142	144	113	146	178	156	...	148.3	92 Trochilus Colubris "											
132	119	138	127	108	128	140	....	144	...	129.8	93 Tyrannus Carolinensis "											
139	156	130	139	119	134	132	167	141	....	139.9	94 Dolychonyx oryzivorus"											
122	149	133	151	143	139	141	177	142	....	144.4	95 Spinis tristis "											
138	148	188	145	152	135	152	143	141	....	149.3	96 Setophaga ruticilla "											
....		106	150	124	142	160	....	....	...	136.6	97 Ampelis cedrorum "											
131	131	134	124	138	132	131	154	149	110	133.7	98 Chordeiles Virginianus..............											
101	107	110	112	116	119	115	121	112	108	112.5	99 First piping of frogs											
107	113	118	123	120	126	128	118	121	112	119.0	100 First appearance, snakes											

THUNDERSTORMS—PHENOLOGICAL OBSERVATIONS, NOVA SCOTIA, 1911.

The indices indicate the number of stations from which the Thunderstorms were reported on the day of the year specified

OBSERVATION STATIONS.

1. Yarmouth and Digby.	2. Shelburne, Queens and Lunenburg.	3. Annapolis and Kings.	4. Hants and South Colchester.	5. Halifax and Guysboro.	6. S. Cobequid Slope (S. Cum. & Col.)	7 North Cum., Col., Pictou and Antig.	8. Richmond and Cape Breton.	9. Bras d'Or Slope (to South East).	10. Inverness Slope (to Gulf N. W.)	Total reports of Thunderstorms for year 1911.
....	....	....	....	....	....	30	....	....	....	30
....	....	....	....	....	81	....	....	....	....	81
86	....	....	....	....	....	....	....	....	....	86
....	87	....	87	....	....	....	....	....	87	87^{3}
....	89^{6}	89^{3}	89^{9}	89^{4}	....	89	....	....	....	89^{23}
....	90^{2}	90^{10}	90^{4}	90^{2}	90	90	....	....	....	90^{20}
....	....	....	....	....	....	92	....	....	....	92
....	....	....	....	....	96	96^{4}	....	....	....	96^{5}
....	....	....	....	....	....	97^{7}	97	....	97	97^{9}
....	....	....	....	....	....	....	98	....	....	98
....	....	....	....	....	99	....	....	....	....	99
....	....	....	....	101	....	....	....	....	....	101
....	....	106^{2}	106^{4}	....	106^{5}	106	....	....	....	106^{12}
....	....	....	....	....	....	....	109	....	....	109
....	....	....	....	114	....	....	....	....	....	114
....	....	....	....	....	....	....	116	....	....	116
....	....	....	....	....	....	118	....	....	....	118
120	120	....	....	....	....	120^{3}	....	....	....	120^{5}
121^{3}	121	121	....	....	121	....	....	....	....	121^{6}
....	....	....	....	122	....	....	122	....	....	122^{2}
....	....	....	....	....	125	....	....	....	....	125
....	....	....	....	....	....	126	....	....	....	126
....	129	....	....	129	129	129	....	....	....	129^{4}
130	....	....	....	....	....	130	....	....	....	130^{2}
131	....	....	....	....	....	131	131	....	....	131^{3}
....	132^{7}	132^{7}	132	132^{2}	132^{3}	132^{6}	132^{3}	....	....	132^{29}
133	133	133^{5}	133^{3}	.	133	133^{12}	133^{2}	133	....	133^{26}
....	....	....	134	....	134	134	....	....	....	134^{3}
....	....	135	....	....	....	....	....	....	....	135
....	....	136	....	136	....	....	....	....	....	136^{2}
....	....	137	....	....	137	....	....	....	....	137^{2}
....	139^{2}	....	....	....	139	....	....	....	....	139^{3}
....	140	140^{2}	....	140	....	....	....	....	....	140^{4}
141^{2}	141^{2}	141^{2}	141^{5}	141^{10}	141^{7}	141^{10}	141^{2}	141	....	141^{41}
142	142^{16}	142^{6}	142^{5}	142^{2}	142	142^{7}	....	....	....	142^{38}
....	144	144	....	....	144	....	....	....	....	144^{3}
....	....	145	....	....	....	....	....	....	....	145
....	....	....	....	146^{2}	146	....	....	....	....	146^{3}
....	147	....	....	....	....	147	147	....	147	147^{4}

THUNDERSTORMS—PHENOLOGICAL OBSERVATIONS, N. S., 1911—*Continued.*

The indices indicate the number of stations from which the Thunderstorms were reported on the day of the year specified.

OBSERVATION STATIONS.

1. Yarmouth and Digby-	2. Shelburne, Queens and Lunenburg.	3. Annapolis and Kings.	4. Hants and South Colchester.	5. Halifax and Guysboro.	6. S. Cobequid Slope (S. Cum. & Col.)	7. North Cum., Col., Pictou and Antig.	8. Richmond and Cape Breton.	9. Bras d'Or Slope (to South East).	10. Inverness Slope (to Gulf N. W.)	Total reports of Thunderstorms for year 1911.
148^{3}	.....	148^{4}	.....	148^{4}	148^{5}	148^{5}	148	......	......	148^{22}
149^{8}	149^{18}	149^{16}	149^{10}	149^{1}	149^{7}	149^{21}	149^{4}	149	149	149^{102}
150^{3}	150^{8}	150^{2}	......	150^{56}	.....	150^{4}	150^{2}	....	.....	150^{24}
151	151	.....	....	151^{2}	151	151	....	151	.....	151^{7}
......	.....	152	....	152	....	.....	.....	152	....	152^{3}
.....	......	....	....	.....	153^{2}	.....	......	.....	......	153^{2}_{3}
......	154	.....	..	154	....	.....	154	...	.....	154_{9}
......	155^{13}	155^{2}	155^{7}	155^{4}	155^{2}	155	.....	....	......	155^{2}
......	156^{8}	156^{2}	156^{10}	156^{16}	156^{3}	156	....	.....	.....	156^{44}
......	157	.....	.....	......	157	......	......	......	.....	157^{2}
158	......	....	...	.....	...	.....	...	.....	.....	158
160	160	....	.....	.....	....	160	.....	......	.....	160^{3}
......	.....	.....	162	....	....	.....	.....	......	.....	162
163^{3}	163	.....	......	163	.....	163	163	......	.....	163^{7}
164^{6}	164^{7}	164^{7}	.....	....	.....	......	.....	....	......	164^{20}
165	165^{12}	165^{4}	165^{6}	165^{19}	.....	165^{2}	165^{5}	165	165^{2}	165^{52}
.....	166	......	.....	.....	.....	166^{2}	....	...	....	166^{3}
.....	167^{4}	167	......	167	....	......	167	....	....	167^{7}
.....	168	.....	......	168^{4}	....	......	168	......	....	168^{6}
.....	......	.....	....	.....	.....	169^{2}	....	......	....	169^{2}
......	170	170^{2}	.....	170^{6}	170	170^{9}	170	......	....	170^{20}
171^{2}	171^{2}	171^{8}	171^{11}	171^{17}	171^{2}	171^{19}	171^{2}	171	171	171^{65}
172	172^{9}	172	173^{3}	172^{14}	172	172^{9}	172^{2}	....	172	172^{41}
173^{3}	173^{3}	.....	173^{2}	173^{6}	173^{2}	173	173	.....	....	173^{18}
174^{2}	174^{3}	174^{4}	174^{6}	174^{11}	174^{7}	174	.....	174	.....	174^{35}
......	.....	......	......	175^{2}	......	.....	....	.....	....	175^{2}
......	......	....	....	....	....	177^{2}	....	...	....	177^{2}
....	......	184	....	.....	184	184	.....	.....	....	184^{3}
185	......	185	..	.....	......	....	....	.....	.....	185^{2}
.....	......	.....	.....	...	.....	.	....	186	.....	186
.....	......	......	.....	.....	......	....	......	189	.....	189
.....	....	...	......	.....	...	.....	....	197	......	197
......	......	.....	.....	.....	......	.....	.....	198	.....	198
......	.....	....	..	.....	...	.....	....	200	..	200
......	......	.....	.....	.....	.....	.....	.....	204	.....	204
......	.....	.....	.....	.....	......	.....	....	207	....	207
......	....	.....	.....	....	......	....	......	208	....	208
.....	......	...	......	....	....	..	......	211	.....	211
......	.....	....	.....	.....	....	....	.....	216	.....	216

THUNDERSTORMS—PHENOLOGICAL OBSERVATIONS, N. S., 1911—*Continued.*

The indices indicate the number of stations from which the Thunderstorms were reported on the day of the year specified.

OBSERVATION STATIONS.

1. Yarmouth and Digby.	2. Shelburne, Queens and Lunenburg.	3. Annapolis and Kings.	4. Hants and South Colchester.	5. Halifax and Guysboro	6. S. Cobequid Slope (S. Cum. & Col).	7. North Cum., Col., Pictou and Antig.	8. Richmond and Cape Breton.	9. Bras d'Or Slope (to South East).	10. Inverness Slope (to Gulf N. W.)	Total reports of Thunderstorms for year 1911.
...	...	...	...	...	...	...	...	217	...	217
...	...	...	...	...	...	...	...	218	...	218
...	...	...	...	...	...	...	...	224	...	224
...	...	...	...	...	...	225	...	...	...	225
...	...	...	...	...	...	...	...	226	...	226
230	...	...	...	...	...	...	...	...	...	230
237	...	...	...	...	...	...		...	...	237
238	...	...	...	...	...	...	...	...	...	238
...	244	...	...	...	...	...	...	...	...	244
...	260	...	...	...	...	...	...	...	...	260
...	268	...	...	...	...	...	...	...	...	268
...	...	...	...	...	269	...	...	...	...	269
...	...	...	...	...	...	...	273	...	...	273
...	274^4	274^4	274	...	274^4	...	...	...	...	274^{13}
...	...	...	...	...	...	...	...	277	...	277
...	...	...	...	...	...	...	297	...	...	297
...	...	...	...	...	...	...	298	...	...	298
...	...	...	...	301	...	...	...	...	...	301
...	...	...	...	309	...	...	...	...	...	309
...	315	...	...	...	...	...	...	...	...	315
...	...	...	...	318	...	...	...	...	...	318
...	321	...	...	...	...	...	...	...	...	321
...	...	...	...	...	...	...	...	...	333	333
...	...	...	...	336	...	...	...	...	...	336

CLIMATE OF HALIFAX, N. S.*

Meteorological Table (Averages).

Latitude, 44° 39′ north ; Longitude, 63° 36′ west.

Based on official records of THE CANADIAN METEOROLOGICAL SERVICE for from 20 to 24 years.

Brought down to 31st December, 1911.

MONTH	Mean Barometric Pressure at sea level. 24 years observations.	TEMPERATURE (Fahrenheit). Mean 24 years obsr.	Absolute Highest. 24 years observations	Absolute Lowest. 24 years observations	Mean Relative Humidity. 20 years obsr.	Per cent. of Cloud. 20 years obsr.
JANUARY	29.97	24.4	55.2	– 16.0	88	64
FEBRUARY	29.94	23.7	50.2	– 16.9	86	62
MARCH	29.92	31.4	60.0	– 9.0	82	60
APRIL	29.93	39.9	79.2	7.2	78	60
MAY	29.98	49.5	90.4	22.1	79	62
JUNE	29.94	57.8	94 4	31.8	81	63
JULY	29.94	64.9	93.0	32.8	86	62
AUGUST	29.97	64.5	93.1	39.2	87	55
SEPTEMBER	30.05	58.8	88.2	28.7	87	51
OCTOBER	29.98	48.8	85.7	19.0	86	55
NOVEMBER	30.00	39.6	67.2	4.3	85	68
DECEMBER	29 95	29.1	62.0	– 11.2	86	66
YEAR	29.97	44.4	94.4	– 16.9	84	61

Highest barometer on record, 31.03 ins ; date 5th March, 1904.
Lowest ,, ,, ,, 28.55 ,, ,, 1st April, 1879.
Highest temperature on record, 94 4 ; date, 26th June, 1909.
Lowest ,, ,, ,, – 16.9 ; ,, 25th February, 1876
Greatest precipitation on record, 5.43 ins. ; date 2nd August, 1908.
Average mean temperature, spring months, 40.3.
,, ,, ,, summer months, 62 3.

*Published by permission of R. F. Stupart, Esq., Director of the Meteorological Service, Toronto.

CLIMATE OF HALIFAX, N. S.

Meteorological Table (Averages).

Latitude, 44° 39′ north ; Longitude, 63° 36′ west.

Based on official records of THE CANADIAN METEOROLOGICAL SERVICE for from 20 to 24 years.

Brought down to 31st December, 1911.

Wind.		Precipitation.			Number of Fair Days.	Number of Thunder Storms.	Number of Fogs.
Prevailing Direction. 20 years obsr.	Mean Miles per Hour.	Average Mean. 24 years observations	Heaviest Fall.	Number of Days with .01 Precipn. or more. 24 yrs ob.	20 years observations.		
		Inches	Inches.				
W	12	6.01	10.12	16	15	0	2
W	12	4.71	8.74	13	15	0	1
W	11	5.14	9.88	14	17	0	2
W	11	4.67	8.38	14	16	0	3
W	9	3.78	6.30	13	18	1	5
W	8	3.81	6.97	13	17	1	4
W	7	3.66	8.73	12	19	1	5
W	6	4.59	10.66	13	18	1	3
W	7	4.10	12.10	11	19	1	2
W	9	5.55	15.02	13	18	0	1
N.W.	10	5.87	10.25	15	15	0	1
N.W.	10	5.51	10.25	14	17	0	1
W	9	57.40	15.02	161	204	5	30

Average mean temperature, autumn months, 49.1.
,, ,, ,, winter months, 25.8.
Warmest month of year, July.
Coldest ,, ,, February.
Most precipitation, month of January.
Least ,, ,, July.
Most cloud, month of November.
Least ,, ,, September.

ERRATA

Page 62, seven lines from bottom, for C_{12} read C_{72}.

" 64, nineteen lines from bottom, for $K_3Fe(CN)_6$ read $K_4Fe(CN)_6$.

" 65, eight lines lines from top, for Turnbull's read Prussian.

" 137, eight lines from bottom, for while read whole.

" 143, two lines from top, for *expotential* read *exponential.*

APPENDIX II.

LIST OF MEMBERS, 1911-12.

ORDINARY MEMBERS.

Date of Admission

Bancroft, George R., Academy, Halifax .... Jan. 7, 1908
Barnes, Albert Johnson, B. SC., service inspector Maritime Telephone & Telegraph Co., Halifax .... May 13, 1912
Bishop, Watson L., Supt. Waterworks, Dartmouth, N. S. .... Jan. 6, 1890
Bowman, Maynard, B. A., Public Analyst, Halifax .... Mar. 13, 1884
Bronson, Prof. Howard Logan, PH. D., Dalhousie College, Halifax .... Mar. 9, 1911
Brown, Richard H., Halifax .... Feb. 2, 1903
Budge, Daniel, General Supt. Halifax & Bermuda Cable Co., Halifax .... Oct. 30, 1903
*Campbell, Donald A., M. D., Halifax .... Jan. 31, 1890
Campbell, George Murray, M. D., Halifax .... Nov. 10, 1884
Colpitt, Parker R., City Electrician, Halifax .... Feb. 2, 1903
Creighton, Henry Jermain Maude, M. A., M. SC., DR. SC., F. C. S., Dalhousie College, Halifax .... Jan. 7, 1908
*Davis, Charles Henry, C. E., New York City, U. S. A. .... Dec. 5, 1900
Davis, Harold, S., B. A., Dalhousie College, Halifax .... Mar. 9, 1911
Doane, Francis William Whitney, City Engineer, Halifax .... Nov. 3, 1886
Donkin, Hiram, M. E., Deputy Com. of Mines, Halifax .... Nov. 30, 1892
Fergusson, Donald M., chemist, Acadia Sugar Ref. Co., Halifax .... Jan. 5, 1909
*Forbes, John, Halifax .... Mar. 14, 1883
*Fraser, C. Frederick, LL. D., Principal, School for the Blind, Halifax .... Mar. 31, 1890
Freeman, Philip A., Hx. Elect. Tramway Co., Halifax .... Nov. 6, 1906
Harlow, A. C., Montreal .... Jan. 7, 1908
Harris, Prof. David Fraser, M. D., D. SC., F. R. S. E., Dalhousie College, Halifax .... Feb. 29, 1912
Hattie William Harrop, M. D., Supt. N. S. Hospital, Dartmouth .... Nov. 12, 1892
Hayward, A. A., Halifax .... Nov. 7, 1905
Howe, Prof. Clarence D., B. SC., Dalhousie College, Halifax .... Mar. 9, 1911
Irving, G. W. T., Education Dept., Halifax .... Jan. 4, 1892
Johnston, Harry W., C. E., Asst. City Engineer, Halifax .... Dec. 31, 1894
Kelly, Rev. M. C., St. Mary's College, Halifax .... Jan. 4, 1910
*Laing, Rev. Robert, Halifax .... Jan. 11, 1885
McCallum, A. L., B. SC., analyst, Halifax .... Jan. 7, 1908
McCarthy, Prof. J. B., B. A., M. SC., King's College, Windsor, N. S. .... Dec. 4, 1901
McColl, Roderick, C. E., Provincial Engineer, Halifax .... Jan. 4, 1892
*MacGregor, Prof. James Gordon, M. A., D. SC., F. R. S., F. R. S. C., Edinburgh University, Edinburgh, Scotland .... Jan. 11, 1877
McInnes, Hector, LL. B., Halifax .... Nov. 27, 1889
MacIntosh, Donald Sutherland, B. A., M. SC., Dalhousie Col., Halifax .... Mar. 9, 1911
*McKay, Alexander, M. A., Supervisor of Schools, Halifax .... Feb. 5, 1872
*MacKay, Alexander Howard, B. A., B. SC., LL. D., F. R. S. C., Superintendent of Education, Halifax .... Oct. 11, 1885
Mackay, Prof. Ebenezer, PH. D., Dalhousie College, Halifax .... Nov. 27, 1889
*MacKay, George M. Johnstone, Shenectady, N. Y., U. S. A. .... Dec. 18, 1903
MacKenzie, Prof. Arthur Stanley, PH. D., Dalhousie College, Halifax .... Nov 7, 1905
McKerron, William, Halifax .... Nov. 30, 1891
McLearn, F. H., B. A. .... Oct. 14, 1908
McNeill, Prof. Murray, Dalhousie College .... Jan. 7, 1908

*Life Members.

	Date of Admission
Marshall, Guilford R., B. A., Halifax	Apr. 4, 1894
Moore, Prof. Clarence L., M. A., Dalhousie College, Halifax	Jan. 7, 1908
Morton, S. A., M. A., County Academy, Halifax	Jan. 27, 1893
Murray, Prof. Daniel Alexander, PH. D., Montreal	Dec. 18, 1903
Nickerson, Carleton Bell, M. A., Dalhousie College, Halifax	Mar. 9, 1911
Pickings, H. B., Mines Department, Halifax	May 6, 1908
Piers, Harry, Curator Provincial Museum and Librarian Provincial Science Library, Halifax	Nov. 2 1888
*Poole, Henry Skeffington, A. M. ASSOC. R. S. M., F. G. S., F. R. S. C., CAN. SOC. C. E., HON MEM. INST. M. E., Guildford, Surrey, England	Nov. 11, 1872
*Robb, D. W., Amherst, N. S.	Mar. 4, 1890
Robinson, Ernest, B. A., Canning, N. S.	Jan. 7, 1908
Rutherford, John, M. E., Halifax	Jan. 8, 1865
Sexton, Prof. Frederic H., Director of Technical Education, Halifax	Dec. 18, 1903
*Smith, Prof. H. W., B. SC., Agricultural College, Truro N. S.; Assoc. Memb., Jan. 6, 1890	Dec. 1900
Stapleton, W. C., B. A., Supervisor of Schools, Dartmouth, N. S.	Oct. 14, 1908
*Stewart, John, M. B. C. M., Halifax	Jan. 12, 1885
Wilson, Robert J., Secretary, School Board, Halifax	May 3, 1889
Winfield, James H., Manager, N. S. Telephone Co., Halifax	Dec. 18, 1903
Woodman, Prof. J. Edmund, M. A., D. SC., New York University, New York, U. S. A.	Dec. 3, 1902
*Yorston, W. G., C. E., City Engineer, Sydney, C. B.	Nov. 12, 1892

ASSOCIATE MEMBERS.

Brodie, W. S., B. A., Lunenburg, N. S.	May 7, 1909
*Caie, Robert, Yarmouth, N. S.	Jan. 31, 1890
Connolly, Prof. J. C., PH. D., St. Francis Xavier, Antigonish, N. S.	Nov. 5, 1911
Edwards, Arthur M., M. D., F. L. S., Newark, N. J.	Dec. 12, 1898
Haley, Prof. Frank R., Acadia College, Wolfville, N. S.	Nov. 5, 1901
Harlow, L. C., B. SC., Prov. Normal School, Truro, N. S.	Mar. 23, 1905
Haycock, Prof. Ernest, Acadia College, Wolfville, N. S.	May 17, 1899
James, C. C., M. A., Deputy Min. of Agriculture, Toronto, Ontario	Dec. 3, 1896
Jennison, W. F., Truro, N. S.	May 5, 1903
*Johns, Thomas W., Yarmouth, N. S.	Nov. 27, 1889
*MacKay, Hector H., M. D., New Glasgow, N. S.	Feb. 4, 1902
Magee, W. H., PH. D., Annapolis, N. S.	Nov. 29, 1894
Payzant, E. N., M. D., Wolfville, N. S.	Apr. 8, 1902
Pineo, Avard V., LL. B., Kentville, N. S.	Nov. 5, 1901
*Reid, A. P., M. D., L. R. C. S., Middleton, Annapolis, N. S.	Jan. 31, 1890
*Robinson, C. B., PH. D., New York Botanical Garden, New York, U. S. A.	Dec. 3, 1902
*Rosborough, Rev. James, Musquodoboit Harbour, N. S.	Nov. 29, 1894

*Life Members.

CORRESPONDING MEMBERS.

Date of Admission

Ami, Henry M., D. SC., F. G. S., F. R. S. C., Geological Survey, Ottawa Ontario .... Jan. 2, 1892
Bailey, Prof. L. W., PH. D., LL. D., F. R. C. S., Fredericton, N. B. ... Jan. 6, 1890
Ball, Rev. E. H., Tangier, N. S. .... Nov. 29, 1871
Barbour, Capt. J. H., R. A. M. C., F. L. S., Nowgong, Bundelkhand, Central India. .... Dec. 28, 1911
Bethune, Rev. Charles J. S., M. A., D. C. L., F. R. S. C., Ontario Agricultural College, Guelph, Ont. .... Dec. 29, 1868
Cox, Philip, B. SC., PH. D., Fredericton, N. B. .... Dec. 3, 1902
Dobie, W. Henry, M. D., Chester, England .... Dec. 3, 1897
Faribault, E. Rodolphe, B. A., B. SC., Geological Survey of Canada, Ottawa; Assoc. Memb., March 6, 1888 .... Dec. 3, 1902
Ganong, Prof. W. F., B. A., PH. D., Smith College, Northampton, Mass., U. S. A. .... Jan. 6, 1890
Hardy, Maj.-General Campbell, R. A., Dover, England. (Sole surviving Foundation Member; originally elected Dec. 26, 1862, and admitted Jan. 26, 1862.) .... Oct. 30, 1903
Harrington, W. Hague, F. R. S. C., Post Office Department, Ottawa .. May 5, 1896
Hay, George U., D. SC., F. R. S. C., St. John, N. B. .... Dec. 3, 1902
Litton, Robert T., F. G. S., Melbourne, Australia .... May 5, 1892
Matthew, G. F., M. A., D. SC., LL. D., F. R. S. C., St. John, N. B. .... Jan. 6, 1890
Maury, Rev. Mytton, D. D., Ithaca, N. Y., U. S. A. .... Nov. 30, 1891
Mowbray, Louis L., Hamilton, Bermuda .... May 3, 1907
Peter, Rev. Brother Junian .... Dec. 12, 1898
Prest, Walter Henry, M. E., Bedford, N. S.; Assoc. Memb., Nov. 29, 1894 .... Nov. 2, 1900
Prichard, Arthur H. Cooper, Librarian, Numismatic Museum, New York, U. S. A. .... Dec. 4, 1901
Prince, Prof. E. E., Commissioner and General Inspector of Fisheries, Ottawa, Ontario. .... Jan. 5, 1897

LIST OF PRESIDENTS

OF THE NOVA SCOTIAN INSTITUTE OF NATURAL SCIENCE, AFTERWARDS THE NOVA SCOTIAN INSTITUTE OF SCIENCE, SINCE ITS FOUNDATION ON 31ST DECEMBER, 1862.

	Term of Office.
Hon. Philip Carteret Hill, D. C. L.	31 Dec. 1862 to 26 Oct. 1863
John Matthew Jones, F. L. S., F. R. S. C.	26 Oct. 1863 " 8 Oct. 1873
John Bernard Gilpin, M. A., M. D., M. R. C. S.	8 Oct. 1873 " 9 Oct. 1878
William Gossip	9 Oct. 1878 " 13 Oct. 1880
John Somers, M. D.	13 Oct. 1880 " 26 Oct. 1883
Robert Morrow	26 Oct. 1883 " 21 Oct. 1885
John Somers, M. D.	21 Oct. 1885 " 10 Oct. 1888
prof. James Gordon MacGregor, M. A., D. SC., F.R.S.. F.R.S.C.	10 Oct. 1888 " 9 Nov. 1891
Martin Murphy, C. E., D. SC., I. S. O.	9 Nov. 1891 " 8 Nov. 1893
Prof. George Lawson, PH. D., LL. D., F. I. C., F. R. S. C.	8 Nov. 1893 " 10 Nov. 1895
Edwin Gilpin, Jr., M. A., LL. D., D. SC., F. G. S., F. R. S. C., I.S.O.	18 Nov. 1895 " 8 Nov. 1897
Alexander McKay M. A.	8 Nov. 1897 " 20 Nov. 1899
Alexander Howard MacKay, B. A., B. SC., LL. D., F. R. S. C.	20 Nov. 1899 " 24 Nov. 1902
Henry Skeffington Poole, M A., D. SC., A. R. S. M., F. G. S., F. R. S. C.	24 Nov. 1902 " 18 Oct. 1905
Francis William Whitney Doane, C. E.	18 Oct. 1905 " 11 Nov. 1907
Prof. Ebenezer Mackay, PH. D.	11 Nov. 1907 " 12 Dec. 1910
Watson L. Bishop	12 Dec. 1910 " ———

NOTE—Since 1879 the presidents of the Institute have been *ex-officio* Fellows of the Royal Microscopical Society.

The first general meeting of thc Nova Scotian Institute of Natural Science was held at Halifax, on 31st December, 1862. On 24th March, 1890, the name of the society was changed to the Nova Scotian Institute of Science, and it was incorporated by an act of the legislature in the same year.

The foundation of the Halifax Mechanics' Institute on 27th December, 1831, and of the Nova Scotian Literary and Scientific Society about 1859 (the latter published its Transactions from 4th January to 3rd December, 1859) had led up to the establishment of the N. S. Institute of Natural Science in December, 1862.

Stewart Wallace
75¢